B-1140

Texas Agricultural Extension Service

TEXAS PLANT DISEASES HANDBOOK

Texas Agricultural Extension Service • Zerle L. Carpenter, Director • The Texas A&M University System • College Station, Texas

TEXAS PLANT DISEASES HANDBOOK

Prepared by:

Texas Extension Plant Pathologists

C. Wendell Horne - College Station (Editor & Coordinator)
Jose M. Amador - Weslaco
Jerral D. Johnson - College Station
Norman L. McCoy - Dallas
George L. Philley - Overton
Thomas A. Lee, Jr. - Stephenville
Harold W. Kaufman - Lubbock
Roger K. Jones - College Station
Larry W. Barnes - College Station
Mark C. Black - Uvalde

Texas Agricultural Extension Service
The Texas A&M University System
Zerle L. Carpenter, Director
College Station, Texas

-1988-

ACKNOWLEDGEMENTS

The authors wish to express their sincere appreciation to those individuals who made this handbook possible.

Administration of the Texas Agricultural Extension Service
Dr. J. Artie Browning, Professor and Head - Department of Plant Pathology and Microbiology
Mrs. Karen Jensen, Secretary
Mrs. Barbara Wallace, Senior Secretary
Mrs. Ann Cole, Extension Communications Specialist

We wish to collectively thank those who wrote educational publications and scientific papers that contributed to the text of this handbook. Without knowledge gained from all over the world it would be impossible to prepare a reference like the Texas Plant Diseases Handbook.

TABLE OF CONTENTS

[Blank Page in Original Bulletin]

SOME COMMON VEGETABLE DISEASES

1. FUSARIUM WILT OF TOMATOES AND CROSS SECTION OF STEM

2. SOUTHERN BLIGHT OF TOMATO

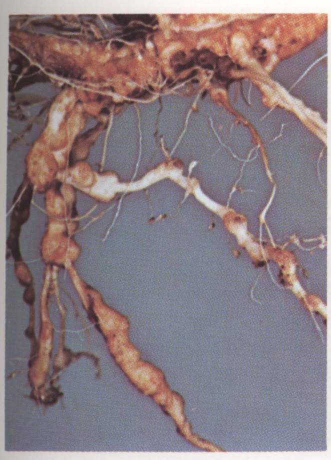
3. BACTERIAL WILT OF TOMATO WITH CUT SECTION OF STEM

4. EARLY BLIGHT OF TOMATO ON LEAF AND STEM

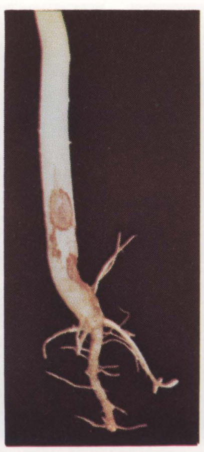
5. GRAY LEAF SPOT ON TOMATO LEAFLETS

6. CORN SMUT

7. POWDERY MILDEW ON LEAF



8. ROOT KNOT NEMATODE GALLS ON ROOTS



9. STEM LESION ON BEAN

10. DOWNY MILDEW. UPPER AND LOWER LEAF SURFACE

11. SQUASH FRUIT ROT

PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

[Blank Page in Original Bulletin]

VEGETABLE DISEASES, II

An Aid to Identification and Control

1. STEM ANTHRACNOSE OF LIMA BEAN

2. SQUASH MOSAIC ON LEAF AND YOUNG FRUIT

3. BACTERIAL SPOT OF PEPPER

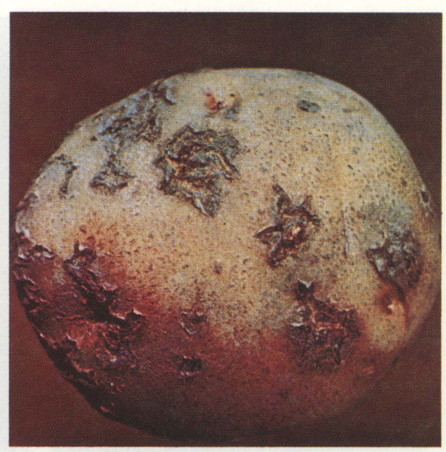
4. DOWNY MILDEW OF CABBAGE
Inset shows Alternaria following damage

5. LETTUCE DROP

6. FUSARIUM WILT OF SWEET POTATO
Inset shows stem damage

7. WHITE LEAF SPOT OF TURNIP

8. RUST OF SNAPBEAN



9. SCAB OF IRISH POTATO

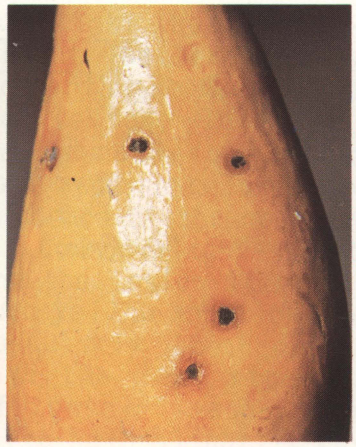
PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

[Blank Page in Original Bulletin]

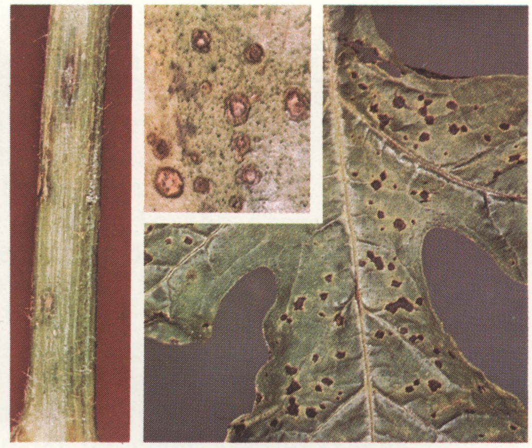
CUCURBIT DISEASES

An Aid to Identification and Control

1. POWDERY MILDEW OF CANTALOUPE



2. SCAB OF SQUASH



3. ANTHRACNOSE OF WATERMELON
Insets show stem and melon damage

4. ALTERNARIA BLIGHT OF CANTALOUPE
Inset shows closeup of leaf spot

5. DOWNY MILDEW OF CANTALOUPE
Inset shows upper leaf surface

6. GUMMY STEM BLIGHT ON LEAF AND STEM

7. FUSARIUM WILT OF WATERMELON STEM

8. ANTHRACNOSE OF CUCUMBER

9. ANGULAR LEAF SPOT OF CUCUMBER

BELLY ROT OF CUCUMBER

PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

[Blank Page in Original Bulletin]

BEAN (SNAP, LIMA, AND BUTTER BEANS)

Phaseolus spp.

Bacterial Blights: Halo Blight (bacterium - Pseudomonas syringae pv. phaseolicola); Common Blight (bacterium - Xanthomonas campestris pv. phaseoli): Plants infected with the halo blight bacterium form greenish-yellow circles around each lesion. Interior of the lesion turns brown. With age, lesions enlarge and coalesce. The entire leaf finally drops. Stem lesions appear as long, reddish colored spots. When the plant begins to set fruit, lesions are formed at the nodes which girdle the stem. This reduces fruit development. Common blight-infected pods do not exhibit the greenish-yellow halo around the lesion like halo blight lesions. Infected leaves with halo blight turn yellow and slowly die while those with common blight turn brown and drop quickly. Both organisms are seed-borne. Entry into the plant is through the leaf stomata. Rain and damp weather encourage development of these diseases. Common blight is more of a problem in warm weather while halo blight is favored by cool temperatures. Both bacteria can live in the soil for two years on plant residue. To control bacterial blight of beans, seed grown in the western United States should be planted. Avoid spreading the disease by not entering the field when the foliage is wet. Follow a three year rotation.

Anthracnose (fungus - Colletotrichum lindemuthianum): This is a seed-borne fungus which attacks all above ground portions of the plant. Infected seed are marked by dark, sunken lesions that extend through the seed coat. Stem lesions are oval and sunken. The center of the lesion is dark brown with purplish to red borders. In early stages, the fungus develops along the veins and becomes purplish to red in color. In advanced stages, leaves become ragged. Infection of the pods results in small, reddish, elongated spots. Older spots are sunken and have brown to reddish-brown borders. The disease is favored by cool, wet springs and falls. It disappears during hot, dry summers. The fungus can survive in the soil for two years in plant debris. Control is obtained by: (1) the use of disease-free seed, (2) crop rotation, (3) not entering fields when plants are wet, and (4) spraying with fungicides.

Cercospora Leaf Spot (fungi - Cercospora spp.): Lower foliage becomes marked by irregular tan spots one-eighth to one-fourth inch in diameter. Severe infection causes defoliation and plant stunting. It is reported to attack the pod but has only been observed on foliage in Texas. Infection is most severe during periods of extended rainfall, high humidity and temperatures between 75°F to 85°F. No resistance exists among varieties. Fungicide sprays should begin at first sign of disease and continued during cool, rainy conditions.

Root Rot (fungus - Rhizoctonia solani): Bean seed may rot in soil or the young seedling may become stunted. A reddish-brown canker is formed on the stem. Cankers may completely girdle the stem or may only partially girdle it, causing severe stunting. Beans should be planted after the soil has warmed to above 69°F. Beans should follow a grass type crop.

Fusarium Root Rot (fungus - Fusarium solani f. sp. phaseoli): Plants infected with Fusarium are characterized by a reddish discoloration of the tap root. Affected plants are stunted with yellow leaves. Young rootlets formed in the area of the lesion are killed. If weather conditions are favorable, a normal crop may be produced. Avoid soils where Fusarium has been a problem. Long rotations (four to five years) will help reduce losses.

Pod Blight (fungus - Diaporthe phaseolorum): Pod blight of lima beans is first observed as brown pustules of irregular shape on the leaves. Lesions grow to one-fourth to three-fourths of an inch in diameter. During the latter part of the growing season, the fungus spreads to nearby pods, where it causes a pale watery spot. The spot enlarges and becomes darker with age. On pods the spot is marked by dark brown to black pustules on the surface arranged in a ring.

Use seed grown in the western United States and use a three- to four-year rotation. Follow a fungicide program to control the disease when it occurs consistently.

Mosaic (virus): Leaves become puckered and mottled with light and dark-green areas. Infected plants become stunted. The virus is seed-borne and can be spread by aphids. Losses can be reduced by growing resistant varieties and following an approved aphid control program.

Curly Top (virus): Infected plants are stunted and have distorted foliage. It is spread by the beet leafhopper. Use resistant varieties and practice good insect control.

Root Knot: (See section on Root Knot.)

Southern Blight: (See section on Southern Blight.)

Cotton Root Rot: (See section on Cotton Root Rot.)

Sun Scald: In the early spring beans are often affected by a condition in which the young leaves turn light tan in color and die. This may happen to the entire leaf or to only a portion of the leaf. The conditions favoring disease development are cool to moderate temperatures, extended periods of high humidity, and cloudy days followed by a bright sunny day. Damage is usually restricted to only a few scattered leaves.

Rust (fungus - Uromyces phaseoli): Small reddish-brown pustules form on lower side of leaves. The fungus overwinters in crop residue. If rust has been severe, a rotation program should be practiced. Resistant varieties should be used when past experience indicates rust to be a problem. Apply approved fungicides at first sign of infection in the fall.

Powdery Mildew (fungus - Erysiphe polygoni): Powdery mildew is characterized by a white powdery growth on the foliage. Infected pods and foliage become malformed. The fungal spores are spread by wind. Spray with approved fungicides. Powdery mildew seldom becomes an economic problem.

Watery Soft Rot (fungus - Sclerotinia sclerotiorum): The fungus affects the stems, leaves and pods of beans. First signs of infection are small, soft, watery spots that enlarge rapidly under cool, moist conditions. They may enlarge and coalesce and the stem is girdled. Infected pods turn into a soft, watery mass. Following the watery stage the affected tissues dry out and turn brown. Within a short time the brown areas are covered with a dense white fungal growth. With age, the white fungal growth turns gray and is dotted with small, hard black bodies called sclerotia. Most losses occur in shipping. Infected beans tend to stick together.

The disease is favored by temperatures ranging between 60° and 70°F. Long periods of high humidity also favor the development of white mold. Large plants with heavy vine growth encourage disease development.

Sclerotia fall to the ground at maturity where they can lay dormant for as long as ten years. When weather conditions are again favorable, the sclerotia begin growth again. The fungus enters beans directly where pods and leaves come in contact with the developing fungus.

Sclerotia produce small mushroom-like structures which contain thousands of ascospores. The spores are ejected into the air landing on plant parts such as blossoms or decaying leaves and begin to develop. This may be repeated many times resulting in widespread infection.

Every effort should be made to improve air circulation between plants and rows. This can be done by increasing row spacing and decreasing the seeding rate. Excessive applications of nitrogen favor heavy vine growth and should be avoided. During periods of extended cool temperatures and high humidity, fungicides should be applied on a preventive schedule.

Baldhead: Beans emerge and produce cotyledons but nothing is formed above the cotyledonary leaves. This can result from injury from soil insects or fungi, and results from mechanically damaged seed.

BEET (TABLE)

Beta vulgaris

Cercospora Leaf Spot (fungus - Cercospora beticola): Cercospora leaf spot causes small, brown lesions with reddish-purple borders. As the spots enlarge, the center becomes gray with purple borders. Severe infection causes the leaves to drop. Crop residue should be plowed under. High humidity and temperatures around 75 to 80°F are optimum for fungal growth. Foliar sprays with a preventative fungicide should be applied when symptoms first appear.

Curly Top (virus): Plants infected with curly top die prematurely. Young leaves roll inward and eventually turn yellow and die. (See section on Curly Top.)

Mosaic (virus): Leaves appear puckered and mottled with light and dark green areas. Plants are stunted. Chlorosis occurs on infected leaves.

Powdery Mildew (fungus - Erysiphe polygoni): This is a relatively new disease of both sugar and table beets. Infected leaves are covered by a white, powdery fungal growth. Affected leaves turn red. Sulfur-containing fungicides are recommended.

Root Knot Nematodes: (See section on Root Knot Nematodes).

Southern Blight: (See section on Southern Blight.)

CABBAGE, CAULIFLOWER, BRUSSEL SPROUTS, AND BROCCOLI

Brassica spp.

Black Rot (bacterium - *Xanthomonas campestris* pv. *campestris*): Infection usually occurs near margins of leaves. Yellow areas develop along the margins, progressing into the leaf in an inverted-V shape. Veins in the affected areas are black. The bacterium may attack cruciferous plants at all stages of growth. A black discoloration is observed in the stem when it is split lengthwise. Cauliflower is very susceptible to black rot and the interior of the stem may be destroyed by secondary soft rot organisms that attack the black rot infection. It is a seed-borne bacterium which can persist in the soil for only a short time. Some wild plants may act as hosts harboring the bacterium while crucifers are absent from commercial fields. Young plants resulting from infected seed serve as a source of secondary infection. Under crowded conditions in the field and during periods of rain, the bacteria spread quickly to nearby healthy plants. Control is achieved by following a 2 year rotation, by planting disease-free seed, and seed that has been treated with hot water to eliminate seed-borne bacteria.

Fusarium Yellow (fungus - *Fusarium oxysporum* f. sp. *conglutinans*): The first indication of the disease is the yellowish-green color of the foliage. Plants appear wilted and stunted. Infected plants usually show a curved mid-rib and the leaf grows on only one side. The disease may be easily confused with black rot since many symptoms are similar. The fungus can live in the soil for a number of years without a host plant. It infects plants through young rootlets and wounds caused by transplanting or insects. It develops in the water conducting vessels, causing a brown discoloration similar to that produced by the black rot bacterium. The disease is checked by very cold or very hot soil temperature. Resistant varieties and long rotations will avoid crop loss.

Downy Mildew (fungus - *Peronospora parasitica*): The fungus is more noticeable on the underside of leaves as a gray, fluffy, downy growth in well defined spots. Outer leaves of the head will develop small black spots when infected with the mildew fungus. The fungus overwinters in crop refuse. Sanitation, rotation and spraying with a protective fungicide are the most effective control methods. During periods of high humidity and cool temperature, the fungus is difficult to control and is almost always present in cabbage fields.

Black Leg (fungus - *Phoma lingam*): First symptoms occur on leaves and stems as small spots with ashen-gray centers and black dots. The stem lesions gradually enlarge extending to the roots. In advanced stages the root system develops a dry rot. Wilted leaves tend to remain attached to the stem instead of defoliating like plants infected with yellows or black rot. The fungus is carried on seed and can persist on infected plant residue for one or two years. Spread is dependent on dew, rain or irrigation water. Avoid soils where cabbage or related plants were grown within the last four years. Destroy crop residues by shredding and deep burial of crop residue.

Powdery Mildew (fungus - *Erysiphe polygoni*): This disease occurs infrequently on cabbage and related plants. A white, powdery growth is observed on the upper surface of leaves. Protective fungicides can be applied if plants become severely infected.

Alternaria Leaf Spot (fungus - Alternaria brassicae): The first symptom is a minute dark spot on seedling stems and on the leaves. These spots enlarge and are marked with concentric rings, giving a bull's eye appearance. The fungus overwinters on cabbage residue or on seed. Spores are disseminated by wind or water. Hot water treatment, as recommended for black rot, will rid the seed of this organism. Fungicide application will prevent the fungus from developing in the field.

Rhizoctonia or Wire Stem Disease (fungus - Rhizoctonia solani): This disease may appear at different stages of growth. A damping-off phase of the disease will cause young seedlings to die. After seedlings are older, they may be attacked but lesions seldom completely girdle the stems. The infected stems are somewhat smaller than normal and are tough and woody. Older plants can also be attached causing a head rot or a root rot. The causal agent is a common soilborne fungus that attacks many plants. Crop rotation and planting healthy transplants are the most effective means of control.

Internal Tip Burn (physiological): Tip burn causes leaf margins to turn brown. The leaves are buried in the head. Exact nature of the problem has been associated with poor water movement within the plant.

Soft Rot (bacterium - Erwinia carotovora): Soft rot also occurs most commonly when fields become water saturated. Stems become decayed and have a foul odor. During storage and transit, a slimy decay with a foul odor develops. The disease begins in areas that have been bruised, particularly during periods of high temperature and humidity prevail. Proper handling during harvesting, packaging and storing along with keeping temperatures low are the best means of control. Follow a long rotation and plant on raised beds in well drained soil to prevent field infections.

Cabbage Mosaic (virus): Leaves display green and yellow mottled areas. Leaf veins may be lighter in color. Keeping fields and surrounding areas free of weed hosts will help reduce the disease.

Root Knot Nematode: (See section on Nematodes.)

Southern Blight: (See section on Southern Blight.)

CANTALOUPE, CUCUMBER, SQUASH
PUMPKIN AND CRENSHAW

Cucumis and *Cucurbita* spp.

Downy Mildew (fungus - *Pseudoperonospora cubensis*): Angular yellow spots appear on the upper surface of the leaf during periods of high humidity. The underside of leaves, opposite the yellow spots, becomes covered by a grayish growth which is the spore producing structures of the fungus. This growth is more noticeable early in the morning when heavy dew is present. Spores are easily carried by wind from diseased plants. Cool temperatures along with free moisture are ideal for mildew infection and spread. Hot, dry weather may reduce or stop disease development. Resistant varieties should be used when possible. Preventative fungicide applications should begin at the time of blooming and continued at 7 to 10 day intervals until the crop is harvested.

Powdery Mildew (fungus - *Erysiphe cichoracearum* and *Sphaerotheca fuliginea*): This disease appears on the leaves as a white powdery mass composed of the spore-bearing structures of the fungus. Severely infected leaves shrivel and die. The fungus can also grow on petioles and young stems. Infected plants are yellow, stunted, and may die. Fruits are not attacked, but are usually small and deformed. Powdery mildew is favored by cool, dry weather. Spores are air-borne. Varieties of most cucurbits are available that show some degree of resistance to powdery mildew. Preventative fungicide applications will effectively control powdery mildew. New races of the fungus have appeared which are resistant to some fungicides. Several applications at 7 to 10 day intervals may be necessary for optimum control.

Anthracnose (fungus - *Colletotrichum lagenarium*): First symptoms of this disease are spots on the foliage that begin as yellowish or watersoaked area. Spots enlarge and turn brown to black in color. Diseased tissue dries and the center of the spots fall out, giving the leaf a "shot-hole" appearance. Symptoms on fruits consist of circular, black, sunken, cankers varying in size depending on the host plant. When abundant moisture is present, the center of the spot is surrounded by a gelatinous pink mass. The fungus overwinters on old cucurbit vines and residues. It may also be seed-borne. Plants may be infected at any stage of growth. Disease appearance in the field depends mainly on rainy, cool weather for a period of several days. All above ground portions may be infected. Seed treatment, crop rotation and destruction of crop residues are important practices for the control of this disease. Preventative fungicide applications, as recommended for downy mildew control, should be made at seven to 10 day intervals, or more often, if weather conditions are favorable for disease development. Preventative fungicide applications will protect plants against infection.

Gummy Stem Blight (fungus - *Didymella bryoniae*): This disease affects leaves and stems, and is more prominent in the crown at soil level. Leaf symptoms begin with irregular spots that dry and drop out giving the lesion a ragged appearance. The most conspicuous phase of the disease is the brown exudation in the crown of infected plants. Vine cankers are found near the soil line, producing a gummy brown ooze. The fungus overwinters in the soil and on crop residue. The fungus is seed-borne. Once the fungus becomes established, millions of spores are produced which can be readily disseminated to other plants by rain, wind or mechanical equipment. Using disease-free seed or seed that has been treated with a fungicide will prevent the disease from becoming established in new fields. Crop rotation should be practiced. Spraying with some fungicides has also shown to be effective.

Angular Leaf Spot (bacterium - Pseudomonas syringae pv. lacrymans): This disease appears on leaves, stems and fruit. Spots are small, angular, straw-colored and watersoaked. Leaf spots often dry and fall out giving the leaf a "shot-hole" appearance, similar to those caused by anthracnose. Spots on fruit are usually smaller and circular in shape. Bacteria overwinter in crop residue and on seed. Hard rains splash the bacteria to stems and leaves. The disease may reach epidemic proportions during periods of heavy rains, particularly if temperatures remain high. Since the disease is seed-borne, the use of disease-free seed treated with a fungicide is recommended. Crop rotation with non-cucurbit crops is also helpful for control of angular leaf spot. Application of copper fungicide will assist in control. Cucurbits, however, are sensitive to copper when young, and repeated applications of copper may cause yellowing of foliage around the edges of the leaves.

Alternaria Leaf Spot (fungus - Alternaria cucumerina): Small, circular watersoaked spots first appear on the leaves, later enlarging to one and one-half inch or more in diameter. Definite concentric rings and margins appear giving the diseased area a "bull's eye" appearance. The fungus overwinters in crop residue and on other cucurbit plants. Numerous air-borne spores are produced on diseased spots. Crop rotation and seed treatment help. A preventative fungicide program should be followed when the disease occurs consistently.

Choanephora Wet-Rot (fungus - Choanephora cucurbitarum): This disease occurs almost exclusively on crenshaw, squash and pumpkins. The blossom ends of fruit turn black, watersoaked, and covered by a fungal growth. The fungus is usually confined to the end of the fruit, but if conditions favorable for disease development prevail, the entire fruit may decay. Greatest damage by this disease is caused during prolonged damp weather.

Fusarium Rind Rot (fungus - Fusarium roseum): Rind rot of cantaloupes caused by Fusarium roseum, caused considerable damage in the Rio Grande Valley in recent years. Rots appear on the melon rind which at first may go unnoticed. However, after peeling the fruit, large brown decomposed areas may be found in the flesh. Since the disease may go unnoticed in the field, melons may be harvested, packed and shipped without the handlers being aware of the problem.

Cucumber Mosaic (virus): This virus causes prominent vein clearing in young leaves, followed by pronounced mosaic mottle on older leaves, and stunting. With cucumber, the fruit is prominently mottled, misshapen and blistered. The virus is spread by aphids. It does not affect watermelon.

Squash Mosaic (virus): This virus does not affect cucumber, cantaloupe, honeydew and watermelon fruit. Symptoms on leaves are faint mottling and distortion. On squash, prominent vein clearing and mottling occurs. Yellow variety fruits are green with isolated yellow zones and misshapen fruit. The virus is spread by the cucumber beetle.

Tobacco Ringspot Virus (virus): Chlorotic stippling, ringspots and mild vein clearing occur on leaves on cantaloupe, honeydew, and cucumber. Squash leaves are severely affected, often showing leaf perforations. Fruit of yellow varieties are severely misshapen with irregular sunken or raised dark green spots. Watermelon plants have shortened internodes and pronounced upright growth of terminals. On fruits, concentric rings and pimples are scattered over the green rind.

Watermelon Mosaic Virus (virus): Vein clearing and mosaic patterns occur on cucumber, cantaloupe, and squash. Older plants are severely stunted and leaves are malformed with dark green blisters. Runners are twisted and stand upright, a symptom expression usually referred to as "snake head." Fruits are small. Squash fruit develop a typical mosaic pattern. Yellow squash are green with yellow spots. Infected zucchini squash are rough and stunted. In cucumbers, the fruit is mottled partially at the stem end. The virus is spread by aphids and possibly other sucking insects. No resistance exists among currently used varieties. Early insect control is important for the prevention of this disease.

Charcoal Rot (fungus - Macrophomina phaseolina): Symptoms resemble those of gummy-stem blight and other vine diseases of melons. First symptoms are dying of leaves close to the crown. As the disease progresses, entire runners wilt and die. Close observation of the crown will reveal brown cankers on the stems both below and above the soil line. Black, hard bodies produced by the fungus, known as sclerotia, are found on the surface of the cankers. Crop rotation may be of limited use since the fungus affects a large number of hosts, including corn and grain sorghum. There appears to be some difference among the varieties. Soil fumigation with either liquid or gas compounds kept for a few days under a plastic cover may offer another means of control.

Fusarium Wilt (fungus - Fusarium oxysporum f. sp. melonis): This is one of the most severe diseases, especially of watermelons, that causes sudden wilting and plant death about the time that fruits are beginning to enlarge. It also attacks the plant at other growth stages especially during the seedling stage when it may produce damping-off. The causal fungus is soil and seed-borne. The disease seems to be most severe when infected seed are used. Serious losses may occur even where watermelons have not been previously grown. Use disease free seed and utilize long rotational programs. Some varieties are more resistant than others.

Root Knot Nematodes (nematode - Meloidogyne spp.): (See section on nematodes.)

CARROT

Daucus carota var. sativus

Leaf Blight (fungus - Alternaria dauci): Infection occurs mostly on older leaves but young plants may also be attacked. Leaf blight first appears as indefinite brown to black areas with pale yellow centers. Infected leaves shrivel when infection is heavy. Under these conditions foliage appears as if burned by fire. The fungus overwinters in infected crop refuse. Air-borne spores of the fungus are produced in large numbers on old lesions during periods of high humidity. Spores may also be carried on seed. The fungus requires moisture for infection. A preventative fungicide program should be followed where the disease is a threat. Spray interval should be every 10 to 14 days depending on fungicide used.

Leaf Spot (fungus - Cercospora carotae): This disease may occur at any place on the leaf but is most common on margins. Spots are circular in shape and with age they coalesce to form larger spots. Lesions on the leaves are sometimes surrounded by a lighter circle or halo. Lesions on the petioles are enlongated with a pale center and dark margin. Spots on the petiole may encircle it causing defoliation. Leaf spot is distinguished from leaf blight by the nearly circular, sharply defined lesions with a yellow halo. The disease usually occurs during the latter part of the growing season and can be controlled with the same recommendations as for leaf blight.

Powdery Mildew (fungus - Erysiphe polygoni:) Although the fungus does not appear to cause excessive damage, it may cause serious infection under conditions favorable for disease development. Affected leaves are covered by a white, powdery mass of spores. Symptoms may also be found along petioles. Fungicide applications at 10 to 14 day intervals will control the disease.

Root Knot Nematode (nematode - Meloidogyne spp.): Root-knot nematodes seriously damage carrots and cause multiple tap-root formation. Root production is severely limited rendering the crop unmarketable. Nematodes contained in the roots are not harmful to humans when consumed. It is best to select areas free of root-knot nematodes for carrot production. Certain pre-plant nematicides can be used where the soil is infested.

Damping-Off (fungi- Rhizoctonia, Fusarium, etc.): Like many other vegetables, carrot seedlings are susceptible to attack by several kinds of soil-borne fungi, particularly during the periods of cool, humid weather. Infected seedlings wilt, turn brown and die, resulting in poor stands. Plant on a bed, do not overwater, and control weeds as soon as possible after emergence.

Aster Yellows (Mycoplasma): The first symptom of aster yellows is yellowing of the foliage, followed by excessive growth and bunching of shoots. Older leaves become twisted and may fall off. Roots are misshapen, and of poor quality with many adventitious roots. The organism is introduced in the field by leafhoppers from overwintering infected weeds. The disease usually occurs sporadically with little economic loss.

Cotton Root Rot: (See section on Cotton Root Rot.)

CELERY

Apium graveolens var. dulce

Cercospora Blight (fungus - Cercospora apii): Symptoms begin as small, yellowish spots on both sides of the foliage. Spots enlarge quickly changing from yellow to ash-gray with the tissue drying in affected areas. The fungus also attacks leaf petioles and stems. Under conditions of high humidity and warm weather, a gray velvety growth can be seen on the surface of affected spots. The fungus is seed-borne and spores can also be blown in air currents for long distances. Warm temperatures are required for fungus development. Control is obtained by using disease-free seed treated with fungicides and spraying plants with a protective fungicide at regular intervals when disease represents a threat.

Late Blight (fungi - Septoria apiicola): Small, yellowish spots develop on the underside of the leaves which later spread to the entire foliage. Spots enlarge and turn brown, similar to lesions caused by Cercospora. Minute, black fruiting bodies can be found scattered in the affected areas. Lesions with fruiting structures can be seen on petioles and stems. High humidity, free water, and cool temperatures favor disease development. Fungicides recommended for Cercospora blight will also control late blight.

Stalk Rot (fungi - Rhizoctonia solani): A serious disease of celery that is favored by high temperatures and moist conditions. Symptoms are first seen as small lesions on the base of the petioles, near the ground. As the disease progresses, the spots are enlarged, appear watersoaked at first, turning later to a brick-red color. When matured, the spots are sunken and turn to a dark brown color that is characteristic of the disease. The lesion can be a few or numerous, making it necessary to trim a lot of the leaves, thus reducing quality and yield. Shallow planting on raised beds and fungicide applications serve to reduce disease losses.

Root Knot Nematode (nematode - Meloidogyne spp.): (See section on Nematodes.)

CORN (SWEET)

Zea mays var. saccharata

Seed Rots and Seedling Disease (fungi - Pythium spp. Macrophomina phaseolina, Gibberella zeae, Penicillium oxalicum and others): Both seed rots and seedling disease can cause poor stands. Cool wet soils slow seed germination and development of young seedlings so that there is exposure to fungi for a longer period of time. Low quality seed also produce seedlings that are weak and survive poorly in cold wet soils.

Control is obtained by using high quality seed which have been treated with a protective fungicide. Sweet corn should be planted on raised bed after the soil temperature is above 55^{o}F.

Stalk Rot and Kernel Rot (fungus - Fusarium spp.): Infected plants are stunted and delayed in maturity. During periods of high wind plants often lodge. Ears may hang downward on the stalk. The Gibberella stage of the fungus will infect kernels causing them to be pink in color. Infected ears have a strong odor and should not be used as food or feed.

Control stalk rots by rotating with non-related crops, planting in well drained soils and by using treated seed.

Southern Corn Leaf Blight (fungus - Bipolaris maydis): The disease is easy to recognize under field conditions. Spots on the leaves are tan to brown in color. On the ear the fungus causes oblong, bleached spots which penetrate through the shuck layers and finally into the ear.

The fungus overwinters in crop residue and produces spores which can be carried for long distances by wind.

Northern Corn Leaf Blight (fungus - Exserohilum turcicum): This disease is found in most sweet corn fields, yet is seldom severe enough to cause economic loss. Spots produced are larger than those caused by the southern corn leafspot fungus. Spots are from one to six inches long and one-half to one inch wide. With maturity, the center of the spot has a dark brown color. Infection occurs first on older foliage. High humidity and temperatures between 60 to 80^{o}F favor disease development. Varieties vary in their reaction to the fungus.

Brown Leaf Spot (fungus - Physoderma maydis): The fungus causing this disease occurs in most fields but seldom does economic damage. Infection requires high temperatures and presence of surface moisture. The first symptom of the disease is small circular spots. As they mature they turn dark brown. Rotation and deep burial of stalks will help reduce losses to this fungus.

Downy Mildew (fungus - Peronosclerospora sorghi): Infected plants are chlorotic, stunted and have striped leaves. Infected leaves have a downy growth on the underside, toward the basal part.

Potential infection is increased when the crop is grown in soil previously grown to infected sorghum, field corn or sweet corn. Although high populations of spores are produced on the leaf surface, they are short lived and require extended periods of high humidity for infection. Overwintering spores produced between leaf veins exist in the soil for long periods. Practices which hasten the breakdown of crop residue will help reduce the amount of inoculum carried over in the soil. Varieties vary in their reaction to this disease. Growers should consult their county Extension agent for current hybrids and their reaction to this disease.

Crazy Top Downy Mildew (fungus - *Sclerophthora macrospora*): This disease is a problem when fields become flooded early in the life of the plant. The fungus produces swimming spores which require water for mobility.

Infected plants are sterile and have numerous shoots at the base of the stalk. Leaves are thickened, distorted, of a lighter green color than normal leaves. Tassels and ears develop green leafy shoots.

The fungus is commonly found in grasses along the edge of the field. Spores are washed into the field in flood water. Infection of the young corn plants takes place at this time.

Varieties vary in their reaction to this fungus. Due to the low percentage of occurrence, little has been done to rate varieties for their reaction. Avoid fields that flood regularly and plant on a raised bed which will help reduce the exposure of young seedlings to standing or flowing water.

Common Rust (fungus - *Puccinia sorghi*): Common rust occurs in most home gardens and commercial fields, but seldom causes economic losses. Infected leaves have raised spots or pustules formed primarily on the upper surface. The pustules are rectangular, brick red and occur in bands on the leaf. Spores are produced in the pustules, which are blown to neighboring leaves where infection can be repeated. Infection is encouraged by high humidity and cool temperatures (60 to 70°F).

Common Smut (fungus - *Ustilago maydis*): Common smut is often found in fields of sweet corn. Losses from common smut vary based on the amount of infected plants in the field. Galls are formed as the common smut fungus causes cells of the corn plant to increase in size and number. These galls at first are covered with a thin white membrane. As the gall ages, the membranes break open to reveal a black powdery spore mass underneath. The spores are blown to adjoining corn plants where infection is repeated. Common smut of sweet corn is more of a problem during dry weather, which slows down the growth of the corn plant. Plants grown in soils high in nitrogen or plants damaged through cultivation are most susceptible to infection.

To control common smut, use resistant hybrids and plant high quality seed. Sweet corn should be grown on soil that is fertilized according to a current soil test recommendation.

Corn Stunt (spiroplasma): Corn stunt occurs in a small percentage in most sweet corn fields. It seldom reaches levels high enough to cause economic loss. The corn stunt spiroplasma is transmitted by leafhoppers. Infected plants are stunted, young leaves are yellow in color, and with age they take on a reddish-purple color. Internodes are reduced in length and infected stalks are sterile. Control is not required due to the very low percentage of plants that normally show this symptom in the field.

Maize Dwarf Mosaic (virus): Maize Dwarf Mosaic virus is the most common virus disease of sweet corn in Texas. Infected plants have mottled upper leaves that are lighter in color than healthy leaves. The mottled or mosaic pattern consists of alternate yellow and green islands in the leaf tissue. Aphids transmit virus particles from surrounding Johnsongrass. Johnsongrass rhizomes serve as the overwintering host for this virus. Early infected plants may be sterile. Late infection will reduce yields and quality of corn produced. Insect control is not successful due to the feeding pattern of the aphid. Elimination of Johnsongrass and isolation of sweet corn fields from Johnsongrass stands will help reduce the occurrence of this disease. There are a number of hybrids of sweet corn that are resistant.

Charcoal Rot: (See section on Charcoal rot.)

Plant Parasitic Nematodes: (See Root Knot section and other nematode sections.)

EGGPLANT

Solanum melongena

Leaf Spot and Fruit Rot (fungus - *Phomopsis vexans*): This disease is characterized by circular brownish spots on fruit and leaves. On the fruit, soft, sunken spots become rotted and shrivelled. Spray with approved fungicide beginning when fruit is first set and repeat at 10-day to two week intervals until fruit is nearly mature. Use a three year crop rotation. Florida High Bush, Florida market and Florida Beauty are resistant.

Early Blight (fungus - *Alternaria solani*): This disease can be destructive on eggplant at any time in the life of the plant. It can cause seedling dieback known as collar rot. Later infection is on the foliage beginning on the lower part of the plant and developing upward. Spots are characterized by concentric rings which give a target appearance. Plants which are well fertilized and irrigated are not as susceptible. Infection of the fruit pedicels may cause a premature fruit drop. It requires eight to 10 days after infection before visible symptoms develop to the extent that epidemic levels are reached. Injured fruit are more subject to attack by the fungus than healthy fruit. Infection occurs between 60° and 90°F. Long rotations, weed control, adequate fertilizer, and irrigation (furrow) will help reduce losses. Use clean seed and follow a thorough spray program when this disease is a problem.

Colletotrichum Fruit Rot (fungus - *Colletotrichum melongenae*): Lesions on the fruit vary from small spots to one-half inch in diameter. The tissue is sunken, with an area filled with a flesh-colored ooze of fungal spores. Spots vary from one to several on the fruit surface. Severely infected fruit drop to the ground with the pedicel still attached to the plant. The fungus overwinters in plant residue and grows at temperatures of 55° to 95°F with optimum growth at 80°F. Rainfall and overhead irrigation favor disease development. The fungus develops when the humidity is 93 percent or above. Although field sanitation is important, a preventive fungicide spray program is required during periods favorable for disease development.

Wilt (fungus - *Verticillium albo-atrum*): The pathogen attacks nearly 200 species of plants but eggplant and okra are the two most seriously affected vegetables. Young plants appear normal, but become stunted as they develop. Severely affected plants turn yellow. The lower foliage wilts and defoliation occurs. Symptoms continue to progress until death occurs. When the stem is cut, there is a dark brown, discolored band around the vascular system. Infection occurs directly through the root hairs. The fungus survives for indefinite periods in the soil. Survival is aided by weeds which are susceptible to the fungus. Infection takes place when the temperature ranges from 55° to 86°F. Verticillium is favored in its development if the soil is alkaline. Some development takes place at pH of 5.0 but all growth is stopped at a pH of 4.0. Control involves the use of long rotations. Cotton gin trash should be avoided or be well composted if used.

Yellows (Tobacco Ring Spot Virus): The disease causes yellowing and whitening of upper leaves. Later, entire plant becomes yellow and may die. Avoid planting in fields where yellows have occurred and, if warranted, fumigate soil to control nematodes. The dagger nematode is a known vector of the virus.

ENGLISH PEA

Pisum sativum

Powdery Mildew (fungus - Erysiphe polygoni): Plants infected with this fungus are covered with a white powdery mold on the leaves, stems and pods. Infected plants are stunted and eventually die. The fungus is seed-borne. Optimum temperatures for development are between 68° and 75°F. Soils should be kept as dry as possible yet will permit maximum growth. Avoid heavy application of fertilizer and rotate with non-related crops. Powdery mildew is the most serious disease of English peas in Texas.

Bacterial Blight (bacterium - Pseudomonas syringae pv. pisi): The bacterium attacks all parts of the plant. Infected stems become olive brown in color, while the leaflets become yellowish or water-soaked. Young infected pods drop prematurely. Well formed pods become water-soaked.

The bacterium is seed-borne. Rain or irrigation water is necessary for movement of the organism. After infection takes place, four to six days is required before lesions are visible. Optimum temperature for development is 82°F.

Control of this pathogen is through a combination of practices such as drainage, row spacing, seeding rates, weed control, and restricting irrigation only to that needed for maximum plant growth.

Ascochyta Blight (fungi - Ascochyta pisi, A. pinodella, A. pinodes): All three fungi are known to attack peas. Affected leaves have spots which are large, pale brown to dark brown in color. Lesions are papery in appearance and have gray to tan centers marked by small black pycnidia. Infection by some species cause purple lesions. On pods, deep lesions are formed which may have purple margins. The center is tan with black pycnidia.

Planting infected seed results in poor stands. All three species of fungi are seedborne and carry over in crop residue. Rainfall and heavy dews are necessary for infection. No infection occurs when the relative humidity is below 80 percent. Optimum temperatures for the fungus are between 68° and 82°F.

Control is achieved by using clean seed, long rotations (four years or longer), planting in well-drained soil, and deep plowing to remove old crop residue.

Aphanomyces Root-Rot (fungus - Aphanomyces euteiches): Early infection causes complete crop loss due to seedling death. Late infection results in poor plant growth and reduced seed formation. Tissue decay does not develop above the soil line unless the weather is extremely wet. Infection occurs in both wet and dry soils, but is most destructive in wet soils. Optimum temperatures for infection are between 65° and 75°F. The use of high levels of fertilizer will encourage continued root development. Nitrogen acts as a suppressant to fungal growth.

The use of three year rotation, well-drained soil, and the liberal use of fertilizer will help reduce losses from this disease.

Mosaic (virus): Irregular, light and dark, greenish areas and puckering occurs in leaves. Control aphids that transmit the virus.

Chlorosis: (See section on Chlorosis.)

Charcoal Rot: (See section on Charcoal Rot.)

Root Knot Nematode: (See section on Root Knot Nematode.)

GARLIC (SEE DISEASES OF ONIONS)

Allium sativum

LETTUCE

Lactuca sativa

Downy Mildew (fungus - Bremia lactucae): First symptoms are yellowish or light green areas on the upper surface of the leaves. As the lesions enlarge, the fungus produces downy growth on the underside of the leaf. Affected tissue turns brown, sometimes comprising extensive areas of the leaf. Infected leaves are usually invaded by secondary bacteria and fungi causing considerable damage during shipping. The fungus is rarely seed-borne and lives in the soil for very short times. Infection takes place from diseased crop residue and is occasionally found on wild weed hosts. Spores of the downy mildew fungus are wind-borne and are carried considerable distances. Spores germinate and infect leaves, producing symptoms within 5 to 10 days. Climatic conditions play an important role in the development of the disease. Cool, humid weather resulting from rain, heavy dew or fog is ideal for disease development. There are several races of the fungus and varieties differ in their reaction. Resistant varieties may become susceptible when new races of the fungus develop. Varieties resistant to known races should be planted. Preventative fungicide applications at frequent intervals will give satisfactory control of the disease.

Sclerotinia Drop (fungus - Sclerotinia sclerotiorum): The causal organism is a soilborne fungus that infects the stem of lettuce at or near ground level. Lower leaves wilt and collapse, the entire plant wilts and dies. Later, a soft, watery, brown rot destroys the plant. White, cottony growth of the fungus may be found on the surface of leaves and stem. Hard, black resting bodies called sclerotia, can be found in the cottony growth. The fungus is soilborne and can remain in the field for several years. The fungus first infects dead leaves at the base of the plant and later moves to live tissue. Under moist conditions, infection occurs when plants are reaching maturity. Avoiding infested fields is recommended.

Mosaic (virus): Young plants first show a slight leaf rolling, followed by light green to yellow mottling. Foliage has a general unhealthy yellowish color and plants are small or dwarfed. Symptoms vary according to type or variety of lettuce. The virus is seed-borne and overwinters in wild hosts and weeds. Infected seed is the most common source of infection. Once infected plants are present in the field, aphids further spread the virus. The virus can also be mechanically transmitted. There is no cure for mosaic once a plant is infected. Disease-free seed offer an effective means of control.

Big Vein (virus): Infection may appear at any stage of growth. Very young seedlings are killed. Surviving plants are smaller in size, quality of heads is affected and maturity is delayed. Infected leaves have an upright habit of growth and the veins turn yellow and begin to clear. Areas around the veins turn white causing the veins to appear enlarged. The virus is soilborne and may persist in the soil for a long period of time. The virus can be transmitted by Olpidium brassicae, a soilborne fungus found in the rootlets of many growing plants. Avoiding excessive soil moisture and rotation are means of reducing disease losses.

Tip Burn (physiological): Margins of leaves die and turn brown. The first symptoms produced are small, dark brown spots about a quarter of an inch from the edge of the leaf. Tissue around these spots dies and turns brown along the margins. Tip burn usually becomes infected with secondary bacteria causing soft rot. The disease is believed to be related to fluctuations in soil moisture, drastic changes in temperature, and available calcium. No satisfactory control for this disease has been developed.

Damping-Off (fungi - *Rhizoctonia* sp., *Pythium* sp.): Small plants wilt and die soon after emergence. Excessive wet and prolonged cool, wet periods of weather are conducive to damping-off. Use only high quality seed which have been treated with a fungicide. Plantings should be on raised beds.

Soft Rot (bacteria - *Erwinia carotovora*): The bacterium enters through mechanical wounds or following damage caused by other diseases, insects or frost. Once the disease is established, it spreads rapidly in the field if warm weather and other conditions are favorable. There is no practical control of the disease once it becomes established and losses will increase during transit and marketing. Infected or damaged lettuce should not be packed; lettuce waiting to be shipped should be kept refrigerated.

Market Disease (various causes): Several disorders can occur on lettuce after harvest and during transport, which could easily be confused with disease caused by pathogenic organisms. Lettuce can be injured by excessive concentration of carbon dioxide (CO_2), low oxygen levels, exposure to ethylene gas, and fluctuations in temperature. Brown stains on leaves, spotting of midribs, rib discolorations and russet spotting are some of the symptoms usually associated with these disorders.

Nematodes: (See section on Nematodes.)

OKRA

Hibiscus esculentus

Fusarium Wilt (fungus - Fusarium oxysporum F. sp. vasinfectum): The most obvious symptom is a typical wilt, followed by death. Infected plants may be stunted and yellow. The fungus invades the root system and colonizes the vascular system. In doing so, water movement is blocked and toxins from the fungus alter normal cell function. Cutting the base of the stem reveals a dark woody portion. No control is available other than a long rotation. All varieties are susceptible.

Root Knot Nematode (nematode - Meloidogyne sp.): Okra is highly susceptible. Root becomes enlarged and distorted. See the section on root knot nematodes. No resistant varieties are available.

Leaf Spot (fungi - Alternaria sp., Ascochyta sp., Cercospors malayensis, Phyllosticta hibiscina): There are several leaf spotting organisms which attack okra. However, none have been shown to cause economic loss. No control is recommended.

Blossom and Fruit Blight (fungus - Choanephora cucurbitarum): Young fruit and blossoms are attacked by the fungus which gives them a "whiskery" appearance. Infected plant parts are reduced to a soft rotten substance. Disease development is favored by warm, humid weather. Spray with an approved fungicide.

Seedling Disease (fungus - Rhizoctonia sp.): This disease is more likely to occur if okra is planted before soils warm sufficiently in the spring. See the Seedling Disease Section for more information.

Cotton Root Rot (fungus - Phymatorichum omnivorum): Infected plants die suddenly from mid-summer to fall. Leaves usually remain attached to the plant. For more information see the Cotton Root Rot Section.

Charcoal Rot (Fungus - Macrophomina phaseolina): See the section on Charcoal Rot.

Southern Blight (fungus - Sclerotium rolfsii): See the Southern Blight Section.

ONION

Allium cepa

Tip Blight (several causes): Several causes are known to result in the death of the leaf tips of onion plants. Some of these causes can be classified as physiological, while others could be the result of infection by soilborne diseases. Among the most common causes of tip dieback is overcrowding; when onions are planted thick, tip dieback is always present. Other causes of tip blight are damage of the root system by the disease known as pink root, damage by certain insects, particularly thrips and leaf miners, soil-related problems that place the plants under undue stress, and occasionally damage by ozone gas released into the atmosphere during severe thunderstorms accompanied by frequent lightning.

Botrytis Leaf Blight (Blast) (fungi - Botrytis allii, B. squamosa and B. cinerea): Botrytis leaf blight or blast is a serious disease of onion in other onion producing states, such as New York and New Jersey, where it appears almost every season. In Texas, its presence is more sporadic, although during the last few years it has been occurring with alarming frequency. Several species of Botrytis occur on onion leaves; the disease caused by B. allii is usualy called neck rot; that caused by B. cinerea is known as leaf fleck, and the one caused by B. squamosa is known as leaf blight. The disease is frequently associated with small whitish spots occurring along the entire length of the leaf. Most spots have greenish halos that at times appear to be water soaked. When the spots are numerous, the tip of the leaf may die back, giving the field a blasted appearance. However, other causes for these spots are suspected, such as cold rain, sleet, sandblasting and other fungal diseases. Most fungicides used for controlling purple blotch will also control Botrytis leaf blight.

Purple Blotch (fungus - Alternaria porri): The fungus affects leaves, seed, stems and bulbs. At first, small whitish, sunken lesions with purple centers are found on the leaves. These spots later enlarge and eventually encircle the leaf. Later, darkened zones appear on the surface of the leaves, retaining the characteristic purple color. Bulbs can be infected during harvest, curing, storage and transit. The disease will spread rapidly to other bulbs causing extensive damage. Recent research findings indicated that disease occurrence can be predicted accurately by measuring the number of hours that free moisture is present on the leaf surface. When 10 to 12 continuous leaf-wetness hours occur, the disease will develop when it is present. Fungicide application should be made when these conditions occur.

Downy Mildew (fungi - Peronospora destructor): Downy mildew is a relative new disease of onion in the Lower Rio Grande Valley, having made sporadic appearances during the last five years. When it does occur, it can cause severe economic damage to the crop. Symptoms consist of white to violet spots on leaves, later turning dark or almost black. Typical symptom of this disease as it occurs in Texas is a series of contiguous verticle spots up and down the leaves. A fuzzy growth is observed on the surface of the leaves, particularly during periods of high humidity. Fields should be monitored closely, particularly during prolonged cold wet weather, when the disease is more likely to occur. Fungicide applications should begin on plants two to three months old as soon as these conditions prevail. Downy mildew is seldom found in Texas as the season progresses into warmer weather.

Pink Root (fungus - Pyrenochaeta terrestris): Pink root is strictly a soilborne disease. Diseased roots turn pink in color, shrivel and die. As the plant sends out new roots, they become infected and die. Affected plants do not usually die, but bulbs are small and of poor quality. The disease affects only roots. Plants infected with the pink root fungus will also develop the tip blight condition discussed previously. The fungus usually is introduced to new land by transplants grown in infected soil. Once the soil becomes infested, the fungus remains in the soil for many years. Soil fumigation has been shown to be effective for the control of this disease. The cost, however, is high. The use of onion varieties resistant to pink root is the best control for this disease. Rotating fields will also reduce losses. Onions infected with the pink root fungus have also shown a higher incidence of Fusarium basal rot. Crop rotation is very important in attempting to control both of these problems.

Stemphylium Blight (fungus - Stemphylium vesicarium): The fungus causing this disease normally invades dead and dying onion tissue, particularly the tip blight and purple blotch lesions. This disease causes only minimal damage when plants are otherwise healthy. Control can be accomplished with the same chemicals used for purple blotch and tip blight control.

Neck Rot (fungus - Botrytis allii, Botrytis sp.): This disease is frequently unnoticed in the field because damage usually occurs during transit and storage. Diseased tissue at the base of the crown becomes sunken and watersoaked in appearance. A gray fungal growth later forms on the surface, which can be followed by other fungi and bacteria, causing decay. Careful handling of the crop at harvest and prompt drying of onions with heat and air ventilation are the best means of controlling this disease.

Basal Rot (fungus - Fusarium sp.): Disease occurrence starts at the basal plant of the onion bulb, causing the bulb to become soft. When onions are cut, a semi-watery decay is found, advancing from the base of the scales upward. The disease may remain unnoticed until transit, where the decay may continue until the entire bulb is destroyed. The fungus lives in the soil, invading the bulb through wounds or through root scars at the base. High soil temperatures favor disease development. No control practices are available, although crop rotation may be of help in avoiding soils that could have been infested from previous crops.

Black Mold Rot (fungus - Aspergillus niger): Black mold is generally destructive during storage and transit, although it may be observed on maturing onions in the field. The disease can be recognized by the presence of black powdery spore masses of the fungus on the outer scales. Observations indicate that high temperatures (85^{o} to 95^{o}F) and moisture favor disease development. Bulbs should be protected from moisture in the field during and after digging and during transit.

Bacterial Soft Rot (bacterium - Erwinia carotovora): Bacterial soft rot is one of the more prevalent causes of loss in storage onions. The soft rot bacterium can enter the neck tissues as plants approach maturity. As the rot progresses, invaded scales become soft and foul-smelling. Onions with mechanical injuries, sunscald, or bruises are particularly susceptible to bacterial soft rot, especially if they have been held under warm, humid conditions.

PARSLEY

Petroselinum crispum

Leaf Spots (fungi - *Cercospora* sp., *Septoria* sp., *Alternaria* sp., *Phyllosticta* sp.): Small to medium size spots develop on leaves. They are usually yellowish when young and later turn brown. No fungicides are cleared on parsley.

PEPPER

Capsicum annuum

Bacterial Leaf Spot (bacterium - *Xanthomonas campestris* pv. *vesicatoria*): The bacterium causes spots on both foliage and fruit. Small, yellowish green to brown spots develop on the leaves. Under favorable weather conditions, spots become numerous and sometimes coalesce into large spots. Infected leaves turn yellow and fall off. The disease is seed and soilborne. Infected seed serves as source of infection to emerging seedlings. Splashing rains spread the organism from diseased to healthy plants in the field. Control can be obtained by using disease-free seed and starting a preventative fungicide program early in the growing season. Applications should be made at periodic intervals and continued during the growing season. Genetic resistance may be available in certain types of peppers, however, most of the common green pepper types are susceptible.

Damping Off (fungi - *Rhizoctonia*, *Pythium* spp.): Small, emerging seedlings wilt and die soon after emergence. Root systems of surviving plants are damaged, resulting in stunted plants and poor yield. Use high quality seed that have been treated with a fungicide and plant on a well-drained bed.

Leaf Spot (fungus - *Cercospora capsici*): This disease rarely occurs in Texas. Spots on leaves are large and oval or somewhat oblong, with light gray centers. Spots may also be present on the stem. Severely infected leaves turn yellow and drop. The fungus does not live in the soil but is carried in the seed. Most field infections can be traced to infected seed. The spores of the fungus can be carried by wind and splashing rains. Control can be attained by using disease-free seed that are treated with a fungicide. Fungicide applications at 7 to 10 day intervals will check the disease in the field.

Phytophthora Blight (fungus - *Phytophthora capsici*): The disease is caused by a fungus that lives in the soil and may be carried in seed. Infection usually takes place at the soil line; diseased plants may be girdled at the base causing sudden wilting and death of plant. Diseased parts of the stem shows a dark green, watersoaked band extending from the soil line to several inches up the stem. This band later dies and turns brown. When peppers are grown with furrow irrigation, sometimes a single infected row is observed in the field. This is the result of the fungus being carried by water down the furrow from a diseased plant and resulting in the infection and death of several plants in the same row. Planting on a raised bed and avoiding excessive moisture in the plant bed are the best means of controlling this disease.

Southern Blight (fungus - *Sclerotium rolfsii*): The fungus attacks the stem of the plant at or near the soil line, causing the plant to wilt and die. A white, cotton growth is observed on the surface of the stem. Later, pink to brown bodies resembling radish seed appear in the fungal growth. Crop rotation and deep plowing are means of controlling this disease. Soil fungicides may be helpful where Southern Blight has been a problem.

Mosaic (virus): Several viruses are known to attack pepper. Often plants are infected by a combination of viruses, rather than by a single strain. Young leaves of affected plants show a greenish-yellow mottle and may be curved and irregular in shape. Leaves curl upward and under severe infection are bunched, very small and discolored. Plants are stunted and have a bunched appearance. Fruits are small, misshapen and of poor quality. Severe infection can result in the complete failure of the crop. There are no effective means of control. The virus overwinters in perennial weeds and is transmitted from weeds to healthy plants in the fields by aphids. Environmental conditions favoring aphid multiplication and migration into the field will result in severe outbreaks of the disease. Keeping fields clean of weeds around the edges and turnrows and controlling insects may help in reducing spread of the disease. Resistant varieties are now available in limited supply. Check with your county Extension agent on *currently used varieties.*

IRISH POTATO

Solanum tuberosum

Early Blight (fungus - Alternaria solani): Small, angular, brown spots with concentric rings occur on lower leaves. Several spots may run together and kill the leaf. Control through the use of fungicides is suggested.

Late Blight (fungus - Phytophthora infestans): Large, watersoaked areas on leaves and stems. In damp weather, a whitish moldy growth appears on the underside of infected leaves. This fungus causes a firm rot of tubers in field and storage, later becoming a soft rot. Use a resistant variety when possible. Fungicide applications will help control the disease. Harvest should be delayed about 2 weeks when late blight is present until vines are killed by chemical treatment and infected tubers have decayed completely.

Pink Rot of Tubers (fungi - Phytophthora parasitica and P. cryptogea): Diseased tubers are spongy and initially discolored around the point of stolon attachment. Later, they become discolored around the buds and lenticels. The internal tissues appear cream-colored when cut, but turn salmon pink after 15-20 minutes. They gradually become darker, turning black after about 1 hour.

Diseased potatoes have been observed in the Texas High Plains primarily in furrow-irrigated fields with clay soils. Control suggestions are to select sites with good soil drainage and avoiding excessive irrigation late in the growing season.

Scab (fungus - Streptomyces scabies): Rough, corky areas that may be round or irregular occur on tubers. Injury does not extend far into the potato but the appearance is objectional. Scab is less prevalent in acid soils than in alkaline. Avoid alkaline soil amendments such as manure, lime, or ashes. Avoid severely infested fields. Apply heavy irrigation at the time of tuber or early root formation. Use a 4 to 6 year rotation under irrigation. A 3- to 4-year rotation is satisfactory under dry land conditions. Use certified seed of scab resistant varieties. Treat seedpieces (See in the chapter on "Seed Treatment"). Wire worm damage, commonly called "deep scab", is not a disease. It differs in that the pits are deep and tissue has been removed by insect feeding. Sulfur may be used in home gardens to make the soil more acid.

Blackleg (bacterium - Erwinia carotovora subsp. atroseptica): The lower parts of affected stems develop an inky black, slimy, foul-smelling, soft rot. Leaves near tops of vines curl upward and become stunted. Aerial tubers usually form in leaf axils. Severely affected plants die. Tubers from affected plants show black stem-end discoloration and sometimes a severe blacks soft rot in storage. Plant certified, healthy seed in well-drained soil. Cut seed tubers with a disinfected knife. Treat seedpieces and cure properly before planting.

Bacterial Wilt or Brown Rot (bacterium - Pseudomonas solanacearum): Stems discolor (at first only on inside) and plants wilt and die. Tubers with a dark, vascular ring may decay. Avoid infested fields and plant seed from northern states. Discard tubers with dark eyes or with sticky ooze on surface.

Ring Rot (bacterium - Corynebacterium sepedonicum): Resembles brown rot, but stem is not discolored. Use certified seed from areas where ring rot is not permitted.

Scurf and Stem Rot (fungus - Rhizoctonia sp.): Small, hard black bodies adhere to the surface of the tuber. Below ground part of stem turns brown. Aerial tubers are sometimes formed. Rotate crops. Use certified seed. Treat seed as for scab.

Curly Top, Several Mosaics, Leaf Roll, Spindle Tuber (viruses): Plants may be stunted and off-color. Foliage is mottled or leaflets tend to roll up. Tubers are often small, and in case of spindle tuber, elongated. Several viruses can infect potato without causing noticeable symptoms. However, yields can be reduced drastically. Use of seed certified to be true to variety and free of disease agents is the best way to control tuber-borne viruses. Control insects.

Spotted Wilt (virus - Tomato Spotted Wilt Virus): This virus is vectored by thrips insects. Early symptoms are dead spots on upper leaves and death of the upper plant parts. Early leaf symptoms may somewhat resemble early blight, but spotted wilt symptoms will usually be in the top of the plant rather than on lower leaves. Plant seed certified to be free of disease agents. Control broadleaf weeds in and around fields 4 to 5 weeks before planting.

Other Diseases: Potatoes are damaged severely by other diseases including Verticillium Wilt, Fusarium Wilt, Charcoal Rot, Southern Blight, Root Knot Nematodes, and Aster Yellows (also called Purple Top). These are discussed in separate sections in order to provide more information.

RADISH

Raphanus sativus

White Rust (fungus - Albugo candida): White, raised spore masses appear on the underside of leaves. Even though the disease is confined usually to the leaves, it may affect other parts of the plant. The host epidermis is ruptured and powdery masses of spores are produced. Spots may range from minute dots to one-half inch or more in diameter. With mild temperature and high humidity, the disease spreads quickly. Extreme hot or cold temperatures and dry weather will slow the disease progress. The following practices should control white rust: 1) destroy crop residue; 2) cultivate fields prior to planting to destroy all volunteer plants.

Cercospora Leafspot (fungi - Cercospora cruciferarum and C. atrogrisea): The fungus attacks the cotyledons, leaves, and petioles of the host plant. Lesions are circular with gray, brown or slightly off-white centers with slightly darkened margins. Severe infection can cause yellowing of foliage and eventual defoliation. Young seedlings are killed whereas later infection causes a reduction in size of the edible portion. The fungus is soilborne and can live in several weeds or old volunteer plants. Stromata are formed in the leaves and these overwinter in the fallen foliage. When weather conditions favor fungal development, growth resumes. Spores are formed from this tissue and they are carried by wind or splashed onto the foliage by rain.

The disease organism is favored by cool temperatures (55^{o} to 65^{o}F) and free moisture on the leaves.

Deep plowing or removal of infected plant parts will help break the life cycle of the organism. All volunteer members of the cabbage family and cruciferous weeds should be destroyed in and around the area where radishes are to be grown.

Bacterial Leaf Spot (bacterium - Xanthomonas campestris pv. campestris): The bacterium attacks the leaves and petioles causing small tan to white spots with narrow, yellowish, watersoaked zones on the leaves. The spots on the leaf petioles are black, sunken and elongated. Severe infection results in defoliation and, in extremely severe cases, death may occur.

The causal organism is carried over in the crop residue and in infected seed. Once a plant is infected, further spread is by insects, rain, etc. During warm spring days, lesions are visible four to five days after infection. In cooler periods development is slower. The bacterium will grow between temperatures of 41^{o} and 94^{o}F., but is favored by temperatures between 80^{o} and 86^{o}F.

Field sanitation is important in preventing infection. Rotation will also reduce the possibility of the disease becoming a problem. Use high quality seed. Chemicals are not recommended.

Black Root (fungus - Aphanomyces raphani): The fungus attacks radishes at any stage of plant development. Early infection results in seedling death. Some escapes will occur which, although infected, continue to develop. This often is visible as a deep crater type lesion.

Field sanitation and rotation will help reduce the occurrence of black root. Cool wet soil favors development. Planting on a raised bed in well drained soil will prevent losses. Fungicides are not currently recommended for the control of black root.

SOUTHERN PEA
(BLACKEYE, COWPEA)

Vigna unoviculata

Wilt (fungus - *Fusarium oxysporum* f. sp. *tracheiphilum*): The lower leaves turn yellow and fall. Death may be rapid after wilting is noted. Woody tissue in the lower stem is dark brown due to fungal invasion. Wilt is frequently associated with root knot nematode infestations. Control wilt by planting tolerant varieties. Avoid deep cultivation that may injure roots and increase wilt incidence.

Powdery Mildew (fungus - *Erysiphe polygoni*): Symptoms consist of a light, grayish, powdery growth on the leaves, pods and occasionally the stems. This powdery growth is easily rubbed off. When the disease is severe, plants turn yellow and defoliate. Generally, powdery mildew does not damage early planted peas. It can, however, be quite destructive on a fall or late summer crop.

Rust (fungus - *Uromyces phaseoli*): Small, reddish-brown pustules appear on both upper and lower leaf surfaces. Rust can develop rapidly, resulting in severe leaf damage and defoliation. Check current clearances of fungicides effective in controlling rust. Sulfur may be used.

Leaf-Spots (fungi - *Cercospora* sp., *Aristastoma* sp., *Ascochyta* sp., *Colletotrichum* sp., *Stagnospora* sp.): Various sized spots often yellowish in color or with a yellow halo, others brown to purplish; these normally develop first on lower leaves. They are most serious during periods of prolonged moist weather and on late summer or early fall plantings. Severe leaf spotting results in defoliation with subsequent yield reductions. Practice crop rotation; avoid cultivating fields when foliage is wet.

Ashy Stem Blight (fungus - *Macrophomina phaseolina*): Plants die quickly. Lower stem is gray with internal black flecking of tissue. Most serious when mature plants come under moisture stress. Same as charcoal rot. See the section on charcoal rot.

Pod Spot (fungus - *Cladosporium* sp.): Irregular, purplish or blackish spots on pods. Infection of young pods causes curling and shedding. Spots also occur on leaves, characterized by a brownish to purple mold growth on underleaf surfaces. Early defoliation may occur. The disease causing organism is seed-borne. Obtain seed from healthy plants. Field type peas generally are more resistant than garden varieties. Purple hull varieties appear more resistant than blackeyes.

Seedling Disease (fungi - *Rhizoctonia* sp., *Phythium* sp., *Fusarium* sp.): Seed may rot and young seedlings die. The condition is most common on early plantings or when soil contains a large amount of nondecomposed plant residue. Treat seed with an approved fungicide. Avoid planting in wet, cold soils.

Bacterial Blight (bacterium - *Xanthomonas vignicola*): This disease appears as tan to brown angular leaf spots with yellow margins on leaves, pods, and stems. It may cause severe defoliation during periods of high humidity. See section on bacterial blight of bean.

Mosaic (virus): Several viruses may produce a mosaic pattern on peas. These viruses may be found singularly or in combination with others. They cause irregular light and dark green mosaic patterns in the leaves. Some viruses cause thickened, malformed leaves similar in appearance to damage caused by hormone herbicides. The mosaic patterns are best observed on the younger foliage. Plants may be stunted and fail to produce normal pods. It is best to plant healthy, disease-free seed rather than saving seed from a crop that showed infection. Early control of aphids may help prevent spread of virus diseases within the crop. The pinkeye purplehull variety is highly susceptible to Blackeye Cowpea Mosaic Virus (BlCMV). This virus can be seed borne and is common where pinkeye purplehull is grown. Resistant purplehull varieties include Pinkeye Purplehull BVR and Mopod. Crowder type peas have shown good resistance to BlCMV. See variety listing at end of section.

Root Knot (nematode - *Meloidogyne* sp.): Relatively small galls or knots develop on roots of affected plants. See the section on root knot nematode for more information. Resistant or tolerant varieties are available.

Marginal Yellowing and Burning of Leaves (physiological): In sandy soils of East Texas, this may result from potassium deficiency in the soil. Other causes may be drouth, or any factor interfering with normal root functions.

Cotton Root Rot (fungus - *Phymatotrichum omnivorum*): See section on Cotton Root Rot.

Curly Top (virus): See section on Curly Top.

Southern Blight (fungus - *Scelorium rolfsii*): See Southern Blight Section.

SOUTHERN PEA
(BLACKEYE, COWPEA)

Variety and (type)*	Bacterial Blight	Root Knot	Cercospora Leaf Spot	Fusarium Wilt	Blackeye Cowpea Mosaic Virus
Erectset (cream)	R	R	-	-	-
Colossus-80 (crowder)	-	R	R	-	-
Mississippi Silver (crowder)	-	R	-	R	-
Magnolia Blackeye (blackeye)	-	R	-	-	-
Zipper Cream (cream)	-	R	-	-	-
Mississippi Purple (crowder)	R	R	-	R	-
Mississippi Cream (cream)	-	R	-	-	-
California Blackeye No. 5 (blackeye)	-	R	-	-	-
Pinkeye Purplehull-BVR (blackeye)	-	-	-	-	R
Mopod (blackeye)	-	-	-	-	R
White Acre BVR (cream)	-	-	-	-	R

* types -- crowder, cream and blackeye. Pod color and seed color are not always as indicated.

R = Resistant or Tolerant

SPINACH

Spinacia oleracea

White Rust (fungus - Albugo occidentalis): White rust is the major disease of spinach in Texas. White, blister-like pustules form on the lower side of the leaf. In advanced stages, the white lesions form on the upper side of the leaf. Generally, the upper surface will only be chlorotic. Plants infected with the white rust fungus are weak and collapse quickly if environmental conditions are favorable for disease development. Initial outbreaks each season follow source event such as hard rains that deposit soil and oospores on the young plants. The fungus oversummers in soil as dormant thick-walled oospores and may spread within a field by windblown spores. Free moisture on the leaf surface must be present for spore germination and development. The optimum temperature for germination is 54^{o}F. The disease develops most rapidly at 72^{o}F. or during periods of cool, humid nights and mild day temperatures. No variety is totally resistant to white rust but a few have very useful partial resistance, including Green Valley II, Ozarka II, Coho and Fall Green. A disease control program should combine the benefits of cultural practices, partial resistance, a systemic fungicide at planting (in Texas, Ridomil 5G) and protective fungicides sprays (beginning 40-50 days after planting). Cultural practices should include long rotations, planting on beds and furrow irrigation. The risk of developing tolerance to Ridomil fungicide is reduced if all of these disease control practices are used together.

Downy Mildew or Blue Mold (fungus - Peronospora effusa): The downy mildew fungus first causes yellowish areas on the upper side of the leaf. The underneath side of the leaf is marked by a gray to violet-gray fungal growth mat that bears sporangia. The entire leaf is killed on susceptible varieties under optimum environmental conditions. The fungus overwinters in living spinach plants and in the seed. The fungus spores require surface moisture for development. Optimum temperature is around 48^{o}F for germination and 54 to 60^{o}F for development. This disease can be controlled by the use of varieties resistant to races 1, 2 and 3.

Anthracnose (fungus - Colletotrichum spinaciae): Anthracnose shows up as small, dark olive colored spots. As the spots enlarge, they become tan in color. As the lesions coalesce, they kill the entire leaf. During periods of favorable disease development, the foliage appears as if the crop will be lost. With a change in weather, the diseased foliage drops off and the healthy foliage goes on to produce a crop. The fungus overwinters in seed and in crop refuse. Fungicides used in a white rust control will also control anthracnose.

Leaf Spots (fungi - Cercospora beticola, Heterosporium variable): These are minor diseases of spinach which may cause damage in some years. Cercospora leaf spots are white and, usually, small in size. Extended periods of precipitation and high humidity may allow spots to become large and even coalesce. Protective type fungicides offer some control. Ridomil does not control Cercospora.

Heterosporium leaf spots are larger and have a greenish black fungal growth on both sides of the leaf as the disease develops. Control measures are not generally recommended.

Fusarium Decline (fungus - Fusarium oxysporum f. sp. spinaciae): Plants are subject to infection at any stage of development. Infected plants turn yellow and wilt. The lower, older foliage is affected first. Plants which are infected are either stunted or killed. Infected plants lose their feeder roots and the vascular system of the taproot is darkened. The fungus is seed borne and can live in the soil indefinitely. Fortunately, white rust resistant varieties also have Fusarium resistance.

Blight (virus): Cucumber mosaic virus attacks spinach causing plants to become faintly chlorotic. Chlorosis increases until the entire plant becomes yellow. Crown leaves are narrow, wrinkled and develop an inward rolling of the margins. Plants are stunted. Death may occur in some severely infected plants. The virus is aphid transmitted. Most commercial varieties are resistant.

Seedling Disease (fungi- Fusarium spp., Rhizoctonia spp., Pythium spp., Others): Preemergence and postemergence damping off can seriously reduce stands. Rotate with corn, plant after soils have cooled down in the late summer or fall, use a fungicide seed treatment and buy fresh, high quality seed.

Tobacco Ringspot (virus): First symptoms are small, indistinct, chlorotic spots which appear on the young foliage. These may coalesce to form large yellow areas. In advanced stages, leaves take on a copper bronze chlorosis. There is no malformation of the foliage. Affected plants rarely die but remain yellow and stunted. No control measures are known.

Beet Curly-Top (virus): Infected plants are marked by a rosette of tightly curled, small leaves in the center of the plant. As the disease develops, the growing point is killed and the plant dies. The virus is transmitted by beet leafhoppers.

Aster Yellows (mycoplasma-like organism): (See section on Aster Yellows.)

False Root Knot (nematode - Naccobbus crucifera): Plants are stunted; in cases of severe early infection, death will occur. The root system of infected plants is characterized by large galls covered with numerous rootlets. This nematode is particularly damaging on spinach plants in the fall. This nematode does little damage in hot soils.

Root Knot (nematode - Meloidogyne sp.): (See section on Root Knot Nematodes.)

Stress (abiotic - heat and/or saturated soils): The quality of spinach can decrease quickly following stress. Yellowing occurs within a few days after high temperatures and/or flooding. Choose planting dates carefully for your areas and provide good drainage.

SPINACH

Reaction of Spinach Varieties to Blue Mold and White Rust

Variety	White rust reaction*	Blue mold race 3 reaction*	Plant type
Green Valley II	MR	S	semi- to full-savoy
Ozarka II	MR	S	semi- to full-savoy
Coho	MS	R	semi-savoy
Fall Green	MR	MR	semi-savoy
Tyee	S	R	semi-savoy
Skookum	S	R	semi-savoy
Chinook II	S	R	semi-savoy to flat
Crystal Savoy	S	R	full-savoy
Melody	S	S	semi-savoy
612	S	S	full-savoy
Dixie Market	S	S	full-savoy
Iron Duke	S	S	full-savoy
Bloomsdale L.S.	S	S	flat
Wolter	S	R	flat
Femic	S	R	flat
Cascade	S	R	flat
Rainier	S	R	flat
Polka	S	R	flat
St. Helens	S	R	flat
Olympia	S	R	flat

R = resistant; MR = moderately resistant; MS = moderately susceptible;
S = susceptible

SWEET POTATO

Ipomoea batatas

Scurf (fungus - *Monilochaetes infuscans*): Scurf is also known as soil stain. It is most severe in wet or poorly drained soils. Scurf appears as light brown areas on the outside of the roots and are only skin deep. These areas may be small or run together to form large, irregular patches. Although superficial, infection reduces grade and causes undue shrinkage in storage. Avoid use of scurfy seed potatoes. Treat sweet potato roots with fungicide before planting. Practice rotations of three to five years. Avoid planting where organic matter in the soil is not well decomposed.

Root Knot (nematode - *Meloidogyne* sp.): Root cracking is often associated with severe root knot infection. Pitting and other surface blemishes are also noted. The cracking is sometimes confused with growth cracks. The splitting of small whip-like roots with small black surface lesions will reveal tiny, pearly-like nematodes embedded around the blackened areas. These also occur in mature potato flesh but are more easily viewed for diagnostic purposes in smaller roots. Vines may be stunted and show nutritional deficiencies. Root knot can be controlled by selecting only healthy seed roots, free of root knot nematodes. These should be planted in a bedding site that is also free of the nematode and preferably has not been used in many years. Preplant nematicides or soil fumigants will help control field infestations. Most newer varieties such as Jewel, Cordner and Topaz have some degree of resistance.

Stem Rot (fungus - *Fusarium oxysporum* f. sp. *batatas*): Young leaves at the tips of vines turn yellow while older leaves wilt then drop so that the center of the hill becomes bare. Infested slips may die soon after setting or become stunted and yellow. Stems at the soil line may turn slightly blue (blue-stem). The inner stem portion at or below the soil line becomes discolored with brown streaks in the vascular system. Use of stem cuttings rather than slips or sprouts for planting stock will reduce the likelihood of new infections in the field. Control by using resistant or tolerant varieties. Selection of seed roots free of the disease is difficult because external symptoms are not always present. Limited control may be obtained when treating seed with a fungicide for other soilborne diseases.

Black Rot (fungus - *Ceratocystis fimbriata*): Circular, almost black spots appear on the sweet potato. Affected and adjacent areas have a bitter taste. Small, black lesions often completely girdle underground stems. The causal organism fruits abundantly in storage and spores are easily spread by mites so that a few diseased roots may result in severe storage losses. Select seed potatoes carefully at harvest time and again at bedding. Use new soil each season for bedding seed. Cull all slips that appear sickly and those with black spots on lower stems. Crop rotations, clean plant beds and use of a fungicide on planting seed will also aid in controlling black rot. If black rot occurs in storage, the rotted roots should be destroyed and the storage area disinfected.

Soil Rot or Pox (fungus - *Streptomyces ipomoea*): Potatoes are often misshapen with rough, scabby pits or shallow surface lesions that result in scars. Soil rot is most severe in soils approaching alkalinity. Control may be obtained by soil fumigation. Some varieties have tolerance to soil rot.

Foot Rot (fungus - Plenodomus destruens): Foot rot is not as widespread as black rot or stem rot and, therefore, losses to this disease are not as great. On infected vines, the base of the stem turns brown at the soil line and leaves nearest the crown turn yellow and drop. It is most commonly observed from mid-season to harvest. Individual plants may produce few potatoes even though large vines develop during the season. The potatoes that are produced develop a firm brown rot at the stem end. Seldom is the entire root affected. Controls recommended for black rot and scurf will also control this disease. If foot rot is recognized to be a serious problem, then early harvest will aid in reducing losses.

Internal Cork (virus): Foliar symptoms vary from purple ring spots to vein-clearing. Symptoms become masked as leaves grow older. The most characteristic symptom is seen within potatoes since no visible surface symptoms are evident. Slicing a potato lengthwise will reveal brownish to black corky areas inside. If seed potatoes are stored at 60°F., development of the corky areas does not proceed. However, if seed are stored at 70°F., severe corkiness develops. Storing seed potatoes at 70°F. is one way of checking for this disease. The variety Puerto Rico is highly susceptible. Internal cork should not be confused with chilling damage.

Storage Rots (fungi - soft rot - Rhizopus stolonifer, Java black rot - Botryodiplodia theobromae, black rot - Ceratocystis fimbriata, charcoal rot - Macrophomina phaseolina and other): Storage rot losses are greatly reduced when disease control practices are followed that yield high quality sweet potatoes from the field. Some fungi causing storage rots infect roots in the field before harvest while others enter the potatoes through wounds made at harvest or during handling. Decayed spots may be dry or soft, the latter due principally to Rhizopus rot. Sweet potatoes should be cured for seven to 10 days at 85°F. and at 90 percent relative humidity before being stored. Curing allows a natural healing process to take place. Potatoes should be stored at 50° to 60°F. and at 85 to 90 percent relative humidity. Avoid rough handling between curing and storage because additional wounding may occur. Store in a thoroughly clean and disinfected room with adequate ventilation. Do not permit the storage temperature to drop below 55°F. or injury will occur. For control of Rhizopus rot during the processing-to-market interval, apply a fungicide spray immediately after washing, when potatoes are on conveyor belts or rollers.

Cold Damage (physiological): Pithy, dark discolorations will appear internally on sweet potatoes subjected to low temperatures. Temperatures do not have to reach the freezing point to cause damage. Sweet potato is a tropical plant and will suffer injury at temperatures below 55°F.

Growth Cracks (physiological): Scientists have not yet determined the conditions that cause cracking of sweet potatoes. In some varieties, it appears to be an inherited characteristic. Rotation reduces incidence of growth cracks.

Other Diseases: Southern blight caused by Sclerotium rolfsii (common in plant beds), cotton root rot caused by Phymatotrichum omnivorum and root rot caused by Rhizoctonia solani and charcoal rot caused by Macrophomina phaseolina. See appropriate sections for more information on these diseases.

SWEET POTATO

Variety	Root Knot Nematodes	Wilt	Internal Cork	Southern Blight	Soil Rot
Jewel	R	R	R	I	S
Centennial	S	I	I	S	S
Puerto Rico	I-S	S	S	I	S
Jasper	I-R	I-R	R	-	R
Gold Rush	S	R	S	-	S
Nemagold	R	-	S	-	I-R
Redgold	S	-	I	-	S
Topaz	R	R	R	R	S

R = Resistant or Tolerant
I = Intermediate
S = Susceptible

TOMATO

Lycopersicon esculentum

Late Blight (fungus - *Phytophthora infestans*): Lesions produced on the leaves are at first irregular, rather large, greenish-black and water-soaked. These areas enlarge rapidly, becoming brown, and under humid conditions, develop a white moldy growth near the margins of the diseased area on the lower surface of the leaves or on stems. The disease spreads rapidly under humid conditions, destroying quickly large areas of tissue. Fruit lesions occur as large, green to dark brown lesions, mostly on the upper half of the fruit, but they may also occur on other parts. White moldy growth may also appear on fruits under humid conditions. The fungus produces abundant numbers of spores which may be splashed by rains or be airborne. These spores infect healthy leaves, stems and fruit readily if climatic conditions are optimum. Ideal conditions for late blight development are cool nights and moderately warm days with abundant moisture. Hot and dry weather reduces disease development. Infection on tomatoes may occur from nearby potato fields or from airborne spores. Control practices include rotating fields so as not to follow potato or tomato; avoiding planting tomatoes near potatoes; using disease-free seed and transplants. Crops should be sprayed regularly with a fungicide. Spraying should begin whenever weather conditions are favorable for disease development. Applications should continue on a 7 to 10 day schedule until harvest.

Early Blight (fungus - *Alternaria solani*): Early blight is first observed on the plants as small, black lesions mostly on the older foliage. Spots enlarge, and by the time they are one-fourth inch in diameter or larger, concentric rings in a bull's eye pattern can be seen in the center of the diseased area. Tissue surrounding the spots may turn yellow. If high temperature and humidity occur at this time, much of the foliage is killed. Lesions on the stems are similar to those on leaves, sometimes girdling the plant if they occur near the soil line. Transplants showing infection by the late blight fungus often die when set in the field. The fungus also infects the fruit, generally through the calyx or stem attachment. Lesions attain considerable size, usually involving nearly the entire fruit; concentric rings are also present on the fruit. The fungus is cosmopolitan, affecting a wide range of plants and is present in and on the seed and on crop refuse. Infection of young seedlings usually results from fungi and soil; it occurs principally during periods of high humidity and warm temperature. Control practices include the use of disease-free transplants and regular preventative fungicide applications during the growing season.

Gray Leaf Spot (fungus - *Stemphylium solani*): First infection appears as minute, brownish-black specks on the lower leaves that extend through to the undersurface of the leaf. These spots usually remain small, but may enlarge until they are about one-eighth inch in diameter. They become glazed and at times the centers crack and tear across. Infected leaves usually die and drop. Spots also form on the stems. The fungus over-winters primarily on diseased refuse; spread is by airborne spores from diseased to healthy plants. Control measures include crop rotation, seed-bed sanitation and preventative fungicide applications as for the control of late and early blight. Resistant varieties should be used when possible.

Leaf-Mold (fungus - Fulvia (Cladosporium) fulvum): Leaf mold is usually first observed on older leaves near the soil where air movement is poor and humidity is high. At first, diffuse whitish spots appear on the upper surfaces of older leaves; these rapidly enlarge and become yellow. Under humid conditions, the lower surface of these spots become covered with a gray, velvety growth of the spores produced by the fungus. When conditions are proper for fungal development, large areas of the field are infected, plants are weakened and the crop is greatly reduced. The fungus produces abundant spores during periods of high temperature and very high relative humidity. Infection occurs readily, and the disease becomes established in the fields quickly. The best control of this disease is by using a preventative fungicide program at 7 to 10 day intervals, the same as used for late and early blight control.

Buckeye Rot (fungus - Phytophthora parasitica): This disease occurs on tomato mainly on the fruit, particularly where it touches the soil. The fungus is different from the one causing late blight, which affects both leaves and fruit. Buckeye rot is first noticed as a light green water-soaked area on the fruit. Later, dark zonate bands can be seen on the surface of affected areas. The surface of the lesion is usually smooth and firm. With time, the entire fruit will rot. The fungus lives in the soil and it can also affect pepper. The disease is more troublesome in heavy, poorly drained soils during prolonged warm wet weather.

Bacterial Spot (bacterium - Xanthomonas campestris pv. vesicatoria): Infected leaves show small, brown, watersoaked, circular spots about one-eighth inch in diameter. The spots may have a yellow halo; the centers dry out and frequently tear. On older plants the leaflet infection is mostly on older leaves and may cause serious defoliation. The most striking symptoms are on the green fruit. Small, water-soaked spots first appear which later become raised and enlarge until they are one-eighth to one-fourth inch in diameter. Centers of these lesions become irregular, light brown and slightly sunken with a rough, scabby surface. Ripe fruits are not susceptible to the disease. Surface of the seed becomes contaminated with the bacteria, remaining on the seed surface for some time. The organism may also overwinter in alternate hosts, on volunteer tomato plants and on infected plant debris. Moist weather and splattering rains are conducive to disease development. Most outbreaks of the disease can be traced back to heavy rainstorms that occur in the area. Infection of leaves occurs through natural openings; infection of other fruits must occur through insect punctures, sandblasting and other mechanical injury means. Bacterial spot is difficult to control once it appears in the field. Disease-free seed and seedlings should always be used; rotate crops so as to avoid last year's crop residue; use a combination of copper and organic fungicides in a regular preventative spray program at 5 to 10 day intervals. Dry, hot weather usually checks the disease.

Bacterial Canker (bacterium Corynebacterium michiganense): Wilting of leaflets is the first symptom; on older plants the margins of the lower leaflets wilt first, the margins dry and the leaflets curl upward. Light colored streaks appear on stems. These streaks later break open at intervals to form cankers in which bacteria ooze may appear. Fruits are infected on the surface, spots appearing first as very small and snowy-white;

the margins remain white and flat, but the centers become raised, tan colored and roughened. A white halo develops around the spots, which serves to differentiate the disease from other bacterial spots. The canker organism is seedborne and can remain in the soil and diseased plants for some time. Primary infection, however, is mostly from infected seed. Control can be obtained by using disease-free treated seed and clean transplants.

Nailhead Spot (fungus - Alternaria tomato): Leaf symptoms are the same as those caused by early blight on fruits; however, spots are smaller, with slightly sunken centers and dark margins. As the spots become older, the edges become roughened. On ripe fruit, the tissue immediately around the spots often remains green. Control is the same as for early blight.

Anthracnose (fungi - Colletotrichum sp.): At first, infected fruit show small, slightly sunken, watersoaked spots. These spots enlarge, become darker in color, depressed and have concentric rings. Masses of the pink fruiting fungus can be seen on the surface of the lesions in moist weather. Under warm and humid conditions, the fungus penetrates the fruit, completely destroying it. The fungus persists on infected plant refuse in the soil. Fruit may be infected when green and small, but do not show any marked lesions until they begin to ripen. Fruit becomes more susceptible as they approach maturity. Control of this disease involves the use of well-drained soil, crop rotation and a preventative fungicide program as recommended for other diseases.

Fusarium Wilt (fungus - Fusarium oxysporum f. sp. lycopersici): The first indication of disease in small plants is a drooping and wilting of lower leaves with a loss of green color followed by wilting and death of the plant. Often leaves on only one side of the stem turn yellow at first; yellowed leaves gradually wilt and die. The stem of wilted plants shows no soft decay, but when cut lengthwise, the woody part next to the green outer cortex shows a dark brown discoloration of the water conducting vessels. The fungus is soilborne, passes upward into the xylem of the stem. Blocking of the water-conducting vessels is the main reason for wilting. The fungus is most active at temperatures between 80° and 90°F., seldom being a serious problem where soil and air temperatures remain low during most of the growing season. Control can be obtained by growing plants in disease-free soil, using disease-free transplants, and growing only resistant varieties.

Verticillium Wilt (fungus - Verticillium albo-atrum): The first symptom is yellowing of the older leaves, followed by a slight wilting of the tips of the shoots during the day. Older yellowed leaves gradually wither and drop, and eventually the plant is defoliated. Verticillium wilt does not show the one-sided effect as does Fusarium wilt. Leaves from Verticillium infected plants sometimes show brown dead spots that may be confused with those caused by other fungi. However, they are lighter in color and do not show concentric zones as in early blight. In late stages of the disease, only the leaves near the tips of the branch remain alive. When the stem is cut lengthwise, the base shows a discoloration of the woody tissue similar to Fusarium, but is usually darker, and generally it occurs only in the lower part of the stem. The fungus enters the plant through the feeder roots and grows into the stem in the woody conducting vessels just under the cortex. The fungus lives in the soil for a long time and it is exclusively the source of infection. Progress of the disease is favored by cooler temperatures and is retarded by the high temperatures that are favorable to Fusarium wilt. Locating seedbeds and fields in Verticillium-free soil, and using resistant varieties are the most effective means of controlling the disease.

Gray Mold (fungus - Botrytis cinerea): Plants become more susceptible to this disease as they become older. It is mostly a problem in greenhouses, but it can also affect tomatoes in the field. The fungus first becomes established on dead leaves at the base of the plants. A heavy, gray growth of the fungus covers these, and numerous spores are soon found, giving the affected area a cottony appearance. Affected leaves collapse and shrink. The fungus progresses into the stem, producing cankers. Affected fruits first show a watersoaked, soft area in the points of infection. The dark gray growth of the fungus soon is seen on these spots. Regular fungicide applications should help in controlling this disease.

Botryosporium Mold (fungus - Botryosporium sp.): This fungus can often be found on greenhouse tomatoes. It superficially resembles gray mold.

Septoria Leaf Spot (fungus - Septoria lycopersici): Infection usually occurs on the lower leaves near the ground, after plants begin to set fruit. At first, small watersoaked spots are observed, which under ideal conditions will become numerous. Large areas of the leaves may be affected but the individual spots can be recognized. The watersoaked spots become roughly circular, with dark margins surrounding a light gray center. With time, black specks which are spore producing bodies can be seen in the center of the spots. If the spots are numerous, the lower leaves will turn yellow, die and progressively drop from the plant until only a few leaves remain on the top of the plant. The fungus is most active when temperatures range from 60° to 80°F., and humidity conditions are high. The disease is usually not serious during periods of hot, dry weather. The fungus can overwinter on crop residue from previous crops, decaying vegetation and some tomato-related wild hosts. Crop rotation, plowing under crop residues, and clean cultivation will reduce the amount of inoculum in tomato fields. Repeated fungicide applications will keep the disease in check.

Southern Blight (fungus - Sclerotium rolfsii): The first symptom is dropping of leaves suggestive of other wilts. Wilting progresses and plants die quickly. Stems show decay of outer tissues at the ground line. Frequently, they are covered by a white fungal mat in which are embedded numerous small, light-brown bodies about the size of cabbage seed. The fungus can also attack fruits where they touch the soil. The fungus does not grow at temperatures below 68°F.; it requires abundant moisture for growth. Infection takes place below the soil line or close to ground level. Control is obtained by sanitation, crop rotation, and by treating infected soil with a soil fungicide prior to planting.

Blossom End Rot (nonparasitic): Blossom end rot is a physiological disorder of tomato that can appear on fruits at any time in their development, but most commonly appears when fruits are one-third to one-half grown. The initial symptoms are water-soaked spots on the blossom end of the fruit. These spots later enlarge and become black. Secondary infection by other decay causing organisms usually follows. The cause of this disorder is considered to be calcium deficiency in the developing fruit. Extreme fluctuations in moisture, root pruning and excessive nitrogen fertilization can also result in blossom end rot. Best means of control is to maintain a uniform supply of moisture through irrigation and soil mulches. Calcium chloride can be used as a spray for control under some conditions.

Growth Cracks (nonparasitic): Growth cracks result from extremely rapid fruit growth brought on by periods of abundant rain and high temperatures, especially when these conditions take place following periods of stress. Cracks of varying depth radiate from the stem end of the fruit, blemishing the fruit and providing an entrance for decay-causing organisms. No control practices are known.

Tobacco Mosaic (virus): Symptoms are light and dark green mottling of the tomato foliage, and curling and slight malformation of the leaflets. Plants may be somewhat stunted if infected when small, but the plants and fruit are not much reduced in size if plants are not infected until they reach the fruiting stage. Several strains of the virus are known that can cause different symptoms. The virus is highly infectious and readily transmitted by any means that introduces even a minute amount of sap from infected to healthy plants. The most common means of transmission is by handling contaminated plants. The virus may also be present in certain types of tobacco; therefore, smokers may transmit the disease. Control measures are: avoiding handling plants more than necessary, washing hands before handling plants, and protecting healthy plants from infection.

Double Streak Virus (virus): Caused by a combination of viruses. Leaves show a light-green mottling, accompanied by the development of numerous small, grayish-brown, dead spots which have a thick, paper appearance. Numerous narrow, dark brown streaks develop on the stem and leaf petiole. Fruits are often rough and misshapen and on the surface they have small, irregular, greasy, brown patches which render them unfit to market. The virus is transmitted by workers handling the crop. Avoid infection by tobacco mosaic virus, wash hands before starting to work and remove infected plants.

Spotted Wilt (virus): This disease is similar to streak in that it causes streaking of the leaves, stems and fruits. Numerous small, dark, circular spots appear on younger leaves. Leaves may have a bronzed appearance and later turn dark brown and wither. Fruits show numerous spots about one-half inch in diameter with concentric, circular markings. On ripe fruit these markings are alternate bands of red and yellow. The virus also affects other vegetables and many wild hosts and ornamental plants. Thrips can transmit the disease from the wild hosts. For control, eliminate weeds around field edges and turnrows; remove infected plants when small, and control insects in the field.

Curly Top (virus): Pronounced upward rolling and twisting of the leaflets that expose their undersurfaces, stiff and leathery foliage, and a peculiar dull yellowing of the entire plant are typical symptoms of the disease. There is also some purpling of the veins and the plant is usually very stunted. Very few fruits are produced after infection. The virus is not transmitted through the seed or soil, nor is it spread by mechanical means. The main vector is the beet leafhopper that becomes infected by feeding on wild or cultivated plants having the disease. The disease is difficult to control. Keep field surroundings free of weeds. Controlling insects may effect some control.

Root Knot Nematodes (Meloidogyne spp.): Root knot nematodes represent one of the major limiting factors to tomato production. Preventing their entry into growing areas is an important mean of control. Susceptible varieties growing in infested soil will have knots or galls on the root system. Once present it becomes necessary to use a resistant variety or to apply nematicide. Refer to the section on nematodes for more information. Use of resistant varieties is the most effective method of reducing nematode losses.

Greenhouse diseases - All of the diseases affecting tomatoes in the field can damage tomatoes in the greenhouse. If proper precautions are not taken, severe losses can occur to tomatoes grown under greenhouse conditions. Among the most common diseases of tomatoes under greenhouse conditions are:

Soil diseases:	Nematodes, Fusarium wilt
Stem diseases:	Bacterial cankers, Botrytis stem canker, early blight canker
Foliage diseases:	Leaf mold, gray mold, late blight, early blight, mosaic

It is important that special control practices are practiced under greenhouse conditions. Maintaining the proper relative humidity is essential for the control of foliage diseases. Relative humidity should be 85 percent or less, which at times proves to be very difficult. Proper air circulation, ventilation, and temperature control are essential under greenhouse conditions. Sanitation is extremely important in controlling greenhouse diseases. All debris should be collected and destroyed soon after harvest. Tools and equipment should be properly cleaned at periodic intervals. Hands should be washed with soap and water before entering the house, and smoking should never be allowed. The soil should be fumigated before planting to control nematodes and other soilborne organisms. Whether using gas or liquid fumigants, proper rates and methods of applications should be made periodically to control foliage diseases. Some fungicides can be sublimated by fire under airtight conditions. If properly used, they will effectively control these diseases.

Seedling Diseases (fungi - Rhizoctonia sp., Pythium sp.): Seedlings fail to emerge or small seedlings wilt and die soon after emergence. Surviving plants may have infected root systems and watersoaked areas on the stem close to the soil line. As the plants mature, they become more resistant to damping-off. Avoid excessive moisture in the seedbed, plant seed treated with fungicides and use sterilized media for growing transplants.

TURNIP AND MUSTARD

Brassica spp.

White Spot (fungus - Cercosporella brassicae): Cercosporella leaf spot is marked by gray, brown, paper-white centers with slightly darkened margins. With severe infections the entire foliage turns yellow and drops. The fungus is seedborne and overwinters in volunteer plants. Spread within a field is by splashing rain and airborne spores. The disease develops optimally at 55 to 65°F and during periods of high humidity. Protective type fungicides should be applied on a weekly basis beginning when true leaves are formed.

White Rust (fungus - Albugo candida): Symptoms on leaves are characterized by white blister-like pustules on the underside. Cruciferous weeds such as wild mustard and shepherd's purse are often infected and probably supply innoculum for turnip and mustard. Mustard is more susceptible than turnip. The disease is spread by windblown spores and overwinters in crop refuse. Spores germinate at an optimum temperature of 50 to 56°F. Disease development is optimum at 68°F. Control of the disease is based on crop rotation, protective type fungicide sprays and furrow irrigation to keep foliage dry.

Anthracnose (fungus - Colletorichum higginsianum): Infected leaves are covered with small dry, circular, pale-gray to straw colored lesions. Severe infection results in leaf death. On the root, lesions are formed which are gray to light tan in color. Bacterial soft rot often enters the lesions as a secondary disease and causes further loss. The fungus overwinters in fallen leaves, volunteer plants and in certain weeds. It can be seed transmitted. Optimum growth is at a temperature of 79 to 86°F. The presence of moisture is important in disease development.

Long crop rotations, weed control, and good soil drainage will help prevent this disease. Approved fungicides can also be used when the disease appears. Applications should begin at the first sign of disease and should continue at 7 to 10 day intervals as long as weather conditions favor disease development.

Alternaria Leaf Spot (fungus - Alternaria brassicae): First signs are small circular spots on the upper leaf surface which are yellow in appearance. The center becomes sooty black with age. The lesion is characterized by concentric circles with a yellow halo. Roots may also become infected when leaves drop on the soil. The fungus grows best at temperatures between 80° and 104°F. Rain or dews are essential for infection. The fungus is carried under the seed coat.

Downy Mildew (fungus - Peronospora parasitica): The disease occurs in the fall and winter months. The first symptoms are small yellow spots on the upper foliage. As they develop a mycelial growth is visible on the underside of the leaf. This growth is especially visible in mornings following nights with cool temperatures and high humidity. Petiole and stem lesions are indistinct, elongated and gray-to-black. In rainy weather, bacterial soft rot may invade plants weakened by downy mildew.

Fungicides can be used as preventative sprays. It is extremely important to watch fields closely to prevent disease build up.

Black Rot (bacterium - *Xanthomonas campestris* pv. *campestris*): Black rot is found on a large number of cruciferous plants. Infected mustard is marked by a "v" shaped lesion on the leaf. In black rot-infected leaves, the vascular system is black to dark gray. Once the plant is infected, it collapses rapidly. Infected plants which are harvested continue to break down in storage. The bacterium is carried in seed and can survive for a short time in the soil. Disease spread within a field is by rain, irrigation or mechanical injury. All seed should be hot water treated, and rotation of at least 1 year should be practiced with non-cruciferous crops. Treat seed for 20 minutes in 122°F water. Seed should be dried and treated with a protectant fungicide. Do not wet foliage when irrigating.

Bacterial Leaf Spot (bacterium - *Xanthomonas campestris* var. *raphani*): Bacterial leaf spot is also seedborne. On the foliage it causes a small pinpoint lesion olive green and watersoaked. As it develops, the lesion becomes translucent with a watersoaked margin. The bacteria can live in soil and in crop residue and are spread by splashing rains and equipment. Symptoms generally are not visible on the plants until one to two weeks before harvest. Hot water seed treatment and rotation is recommended for the control of this disease.

Turnip Mosaic (virus): Infected plants have and mottled and distorted leaves. The entire plant is stunted and yields are low. The virus is aphid transmitted. Field sanitation is extremely important. At the end of harvest, plants should be plowed under to prevent surviving plants serving as a virus host. Insects should be controlled from seedling emergence until harvest. Remove any diseased plants at first sign of the virus. Fast growing hybrids will sometimes mature before the disease has a chance to spread.

WATERMELON

Citrullus lanatus

Anthracnose (fungus - Colletotrichum lagenarium): Appears first on crown leaves as small, brown-black spots usually after vines begin to "run." During damp weather, orange-pink masses of spores may develop in centers of larger leaf spots. During dry weather the spore masses turn gray. All but the youngest leaves are attached. On fruit the fungus causes sunken spots on the rind. Symptoms may not be visible at harvest but may develop in transit or at the market. Buyers and inspectors discriminate against melons showing evidence of this disease because infected melons decay rapidly. Small anthracnose spots are confused at times with pimples disease (see below). A combination of seed treatment, crop rotation and spraying is necessary for control on susceptible varieties. Avoid soaking seed before planting. (See Seed Treatment section.) It is advisable to grow watermelons, cucumbers, squash or pumpkins only once every five years on the same land. Spray programs should begin when vines start to run and continue at seven-day intervals during humid or rainy weather. Schedules may be lengthened to 14 days during dry weather. Good coverage of foliage is most effective.

Pimples (virus - Tobacco Ring Spot Virus): Small bumps or pimples develop on fruit; most noticeable on dark rind varieties. Tiny brown spots surrounded by yellow may appear on young leaves as a "stippling" effect, sometimes resulting in irregular growth and leaf distortion as leaves age. Infected plants exhibit some stunting and shortening of internodes. Tips of vines exhibit a pronounced upright growth providing a "snake head" effect; raised pimples may appear on lesions on fruit. The disease is most likely to develop during wet weather, accompanied by a noticeable deterioration of crown leaves. The virus is transmitted in seed and by the dagger nematode (Xiphinema sp.). Avoid saving seed from melons showing pimples.

Gummy Stem Blight (fungus - Didymella bryoniae): Early symptoms are round black, wrinkled areas on young leaves and sunken dark areas on stems. Early infection usually comes from diseased seed. On older leaves, irregular brown to black spots develop between leaf veins. As the disease progresses, older stems near the crown, most commonly near a leaf petiole or tendril, are attacked resulting in watersoaked areas that become light brown. Infected vines frequently crack and gum oozes from wounds. Runners frequently die. Fruit are not affected. Treat seed and spray as for anthracnose. Avoid working in fields while vines are wet from rain or dew.

Downy Mildew (fungus - Pseudoperonospora cubensis): Occurs during warm rainy season, primarily in South Texas. Irregular to angular yellowish to brown spots, often vague in outline, appear on upper surfaces on leaves near the crown. Undersides of leaves exhibit a brown mold on wet mornings. Mold may be indistinct during dry weather. Spots enlarge rapidly while turning black, causing the entire leaf to wither and die. Control as for anthracnose.

Leaf Spots (fungi _ Alternaria sp., Cercospora sp.): Round to irregular target spots on older leaves. Spots may be brownish with poorly defined concentric ring patterns or appear as dark rings with light centers.

Control as for anthracnose.

Wilt (fungus - Fusarium oxysporium f. sp. niveum): Young plants are stunted, often yellow. Plants may be killed at any stage of growth. Frequently one runner may wilt suddenly while the rest of the plant appears normal. Internal symptoms are brown streaks in water conducting tissue of crown and runners. Plant certified, quality, treated seed. Practice long crop rotations whenever possible. Use resistant varieties.

Blossom-End Rot (physiological): Browning and shriveling at blossom end of melon. Decay progresses inward. Associated with water stress. Use proper fertilization. Liming is beneficial on highly acid soils.

Watermelon Mosaic (virus): Leaves of infected plants have a mosaic pattern. Leaf lobes will tend to be elongated and the tip will be cupped upward slightly. Runners will be slightly twisted and stand upright, what is known as the "snake head symptom." In some cases the terminal dominance of a runner is broken and the lateral buds develop along the runner and at the crown of the plant. Most of the young fruit is aborted and those that are not aborted are malformed. The virus is aphid-transmitted. Most commercial varieties are susceptible. The virus overwinters in wild cucumbers and other vegetables.

A thorough insect control program will help reduce losses from this disease. Total control is very difficult due to the limited feeding required by aphids for transmission.

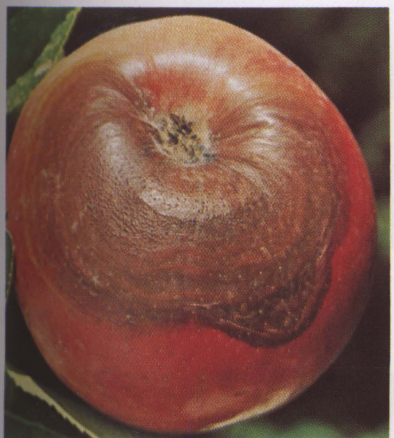
Bacterial Rind Necrosis (bacteria - Erwinia sp.): The first symptoms are numerous brown, dry, hard, discolored areas in the rind. These areas enlarge and may merge to form extensive necrotic areas. The disease rarely extends into the flesh of infected melons in the field. The only external symptom is misshapen fruit in severely affected melons. The disease was first found in south Texas in 1968. In 1978, it was found in the Dell City area in west Texas. No immune varieties have been found. Since usually there are no external symptoms, a small percentage of diseased melons could make the crop unmarketable, as diseased melons cannot be culled. No chemical control is known.

Consult the Chemical Control Supplement (B-1140A) for specific chemical control suggestions.

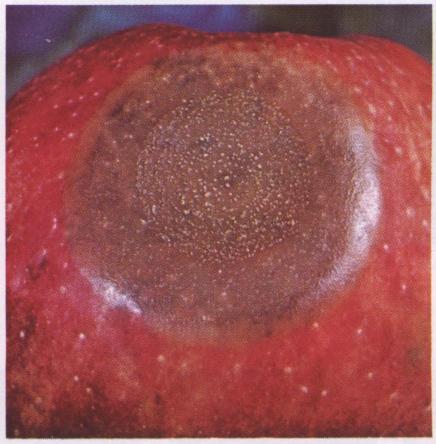
CE 27

APPLE DISEASES

An Aid to Identification and Control



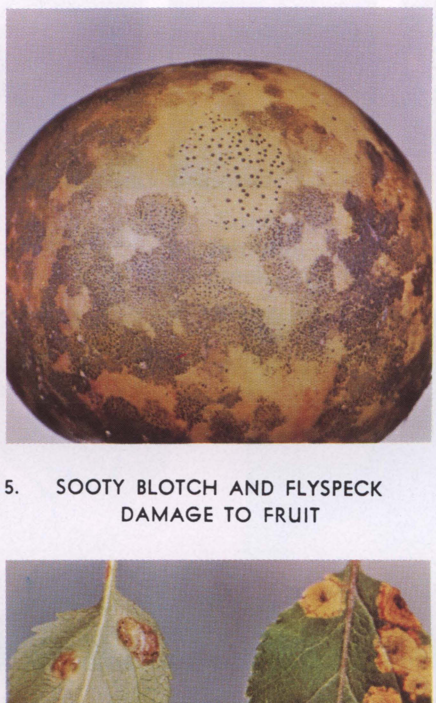
1. BLACK ROT ON FRUIT



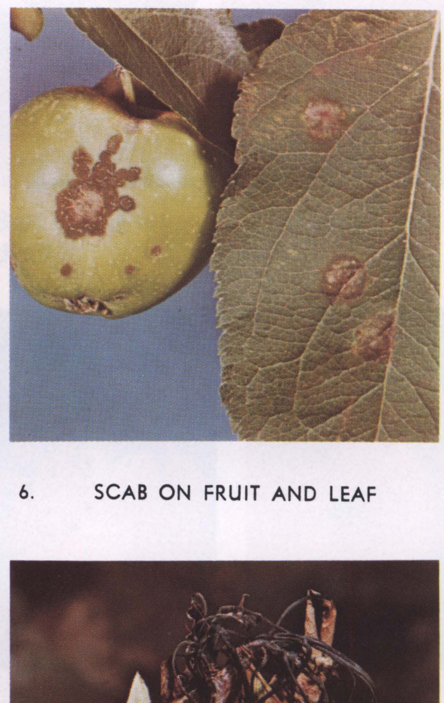
2. BITTER ROT ON FRUIT

3. SCAB ON FRUIT

4. BLACK ROT ON MUMMY AND FROG-EYE STAGE ON LEAF



5. SOOTY BLOTCH AND FLYSPECK DAMAGE TO FRUIT



6. SCAB ON FRUIT AND LEAF

7. POWDERY MILDEW

8. CEDAR-APPLE RUST

9. FIRE BLIGHT

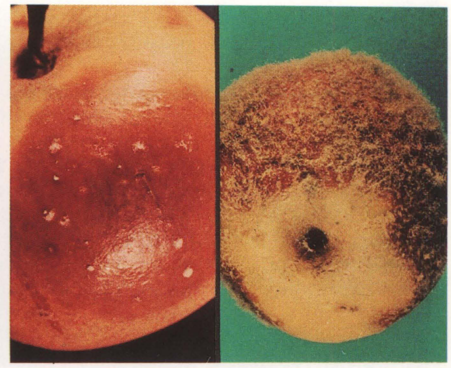
PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

[Blank Page in Original Bulletin]

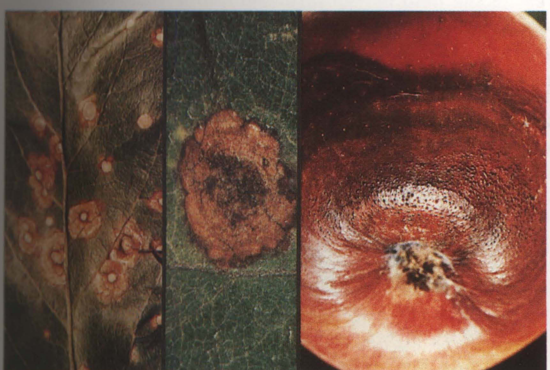
APPLE DISEASES I

1. Northwestern anthracnose or bull's-eye rot

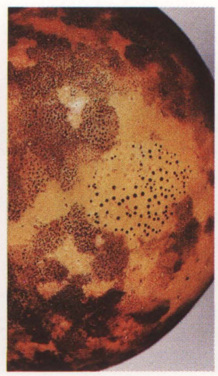
2. Bitter rot



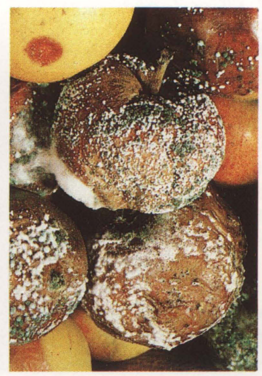
3. Botrytis rot



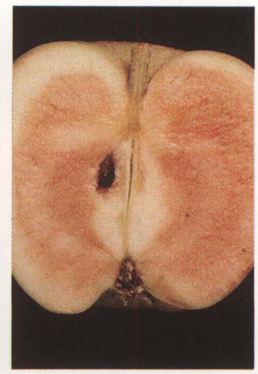
4. Black rot or frogeye leaf spot



5. Sooty blotch and flyspeck

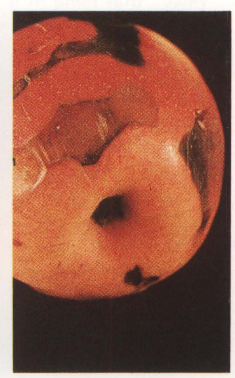


6. Soft rot or blue mold rot

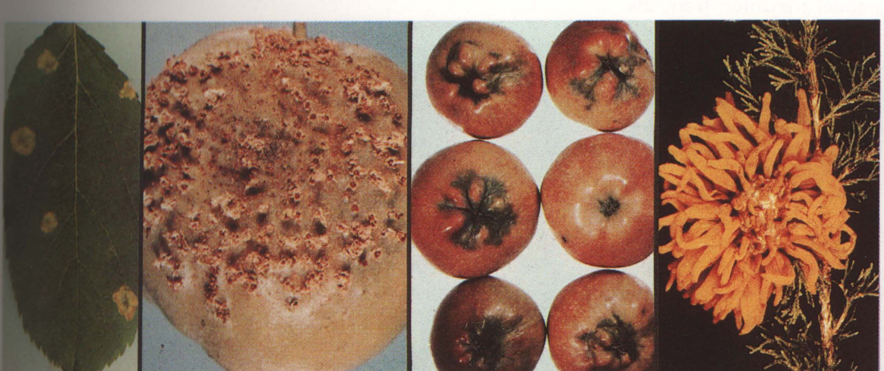


7. Internal breakdown

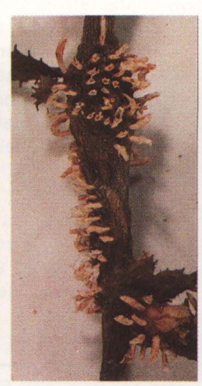
8. Apple scab



9. Soft scald



10. Cedar-apple rust



Quince rust

11. Nectria canker

UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE
COOPERATIVE EXTENSION SERVICE
and VOCATIONAL AGRICULTURE SERVICE

FRUIT DISEASE NO.1
JULY 1982
URBANA, ILLINOIS

APPLE DISEASES I

1. **Northwestern anthracnose or bull's-eye rot**, caused by the fungus *Neofabraea malicorticis*, is a rot primarily of stored fruit and a branch canker disease found mostly in northern areas (chiefly the Pacific Northwest) with a heavy autumn rainfall. The centers of the concave fruit lesions are light brown with a dark brown margin. Later, two or more concentric rings, alternating tan and brown, give a bull's-eye appearance to the rot. Enlarging, elliptical, dark sunken cankers with concentric rings, form in the younger branches. The causal fungus, which can only invade injured tissue, overseasons in cankered limbs and fruit.

2. **Bitter rot** is a fairly firm rot that starts as a small, circular, light brown spot which enlarges rapidly, darkens, and eventually turns almost black. Characteristic of this rot is the saucer-shaped depression in the center and later the concentric rings of tan fungus fruiting structures that form inside the spot. The bitter rot fungus, *Glomerella cingulata*, attacks a wide range of woody plants during warm moist weather in the southern two-thirds of the United States. The source of most infections are mummified fruit and broken limbs.

3. **Botrytis rot** is fairly common on injured mature fruit. The causal fungus, *Botrytis cinerea*, attacks a wide range of plants in cool damp weather. Characteristic of this disease is (1) a small, quarter- to half-inch, somewhat sunken, shallow dry rot at the blossom end of the fruit, (2) a moldy core rot, and (3) a tan-to-medium brown rot covered by a dense, tan-to-gray mold that forms under damp conditions. The fungus overseasons in plant debris.

4. **Black rot or frogeye leaf spot** is caused by the fungus *Physalospora obtusa*, which infects the leaves, fruits and wood. Small purple specks on the leaves enlarge to form round to angular spots with a dark margin and brown or yellowish-brown centers (called frogeyes). Twig, limb and trunk cankers are slightly sunken and reddish brown. Some cankers enlarge each year until they cover several feet. The canker margins are lobed. Diseased fruit develop a brown-to-black rot containing alternating light and dark bands. Such fruit often shrivel into black "mummies" that hang in a tree overwinter. The black rot fungus overwinters in mummified fruit and dead wood.

5. **Sooty blotch and flyspeck** normally occur together on the same fruit. Sooty blotch is caused by the fungus *Gloeodes pomigena*; flyspeck by the fungus *Microthyriella rubi*. Sooty blotch gives a superficial smudgy appearance to affected fruit due to large numbers of minute, black fungus structures (pycnidia) connected by thread-like hyphae. Flyspeck consists of shiny, black dots in groups of 10 to 50 that resemble true flyspecks. Both fungi are superficial and can be removed by vigorous rubbings. They overwinter on the twigs of many woody plants.

6. **Soft rot or blue mold rot** is the most common storage rot. This soft to watery, tan-to-brown or gray rot is most prevalent in fruit with a bruised or broken skin handled roughly at harvest time and later. When humidity is high, gray-to-bright blue cushion-like structures form on the surface of the rot. The primary cause of soft rot is the fungus *Penicillium expansum*.

7. **Internal breakdown** characterizes the gradual transition from the normal to the senescent fruit; the end of normal storage life. The fruit flesh becomes off-white to yellow, then brown and mealy. In advanced stages, the skin is also discolored and the flesh slowly softens. Large apples, late picking, delayed cooling, and high storage temperatures are primary factors that lead to early breakdown. It commonly follows water core and freezing and may be associated with a very low calcium and/or phosphorus status in the tree.

8. **Apple scab** occurs wherever apples and crabapples are grown. Scab infects primarily the leaves and fruit. Velvety, green-to-brown spots, that blacken with age, appear on the leaf. Infection causes the leaves to drop early greatly weakening the tree. Fruit infections resemble leaf infections when young; later becoming brownish-black and corky. Early fruit infections give the fruits a scabby, knotty, misshapen appearance. Such fruit commonly crack and drop early. Small, rough, black, circular, lesions may develop on stored fruit. The scab fungus, *Venturia inaequalis*, overwinters in dead leaves on the ground.

9. **Soft scald** is a physiological or noninfectious disease that attacks fruit picked when immature and stored under unfavorable conditions. The degrees of scald are classified as common scald, soft scald, and soggy breakdown. Common scald first appears as a diffuse browning of the skin, which is most pronounced on light colored varieties. Usually a sharp line exists between affected and normal fruit tissue. Soft scald is characterized by irregular, burn-like brown areas with definitely outlined edges. The flesh beneath these areas is often soft and discolored to a slight depth. In advanced stages, a deep brown flesh rot develops that may extend to three-fourths of the fruit. Sometimes the brown areas in the flesh remain small and firm; at other times large, soft and watery (soggy breakdown). Apple varieties differ markedly in the scald symptoms they express.

10. **Cedar-apple rust**, caused by the fungus *Gymnosporangium juniperi-virginianiae*, commonly occurs on leaves and fruit, and occasionally the twigs. Leaf infections appear as pale yellow spots on the **upper** surface which enlarge, turn orange and exude an orange exudate in the center. Later, black fruiting bodies (pycnia) appear within the spot. On the **underleaf** surface, a number of orange-yellow, tube-like structures (aecia) form in each spot. When severe, leaves may turn yellow and drop early, Fruit lesions appear usually near the calyx end. They resemble leaf lesions, but are much larger. Aecia sometimes appear on the fruit. The rust fungus overseasons on red cedars and other *Juniperus* species where brown to reddish brown galls are formed that produce gelatinuous masses of yellow to bright orange spore-horns during spring rains.

Two other rust fungi attack apples: hawthorn rust (*Gymnosporangium globosum*) and quince rust (*G. clavipes*). Hawthorn rust may infect apple foliage and fruit, producing symptoms similar to those of cedar-apple rust. Quince rust infects apple fruit but not the leaves. Fruit lesions are somewhat similar to those of cedar-apple rust except that they are usually larger, dark green, and commonly produce deep, crater-like depressions. Both the hawthron and quince rust fungi overseason on *Juniperus* species. The quince rust fungus produces somewhat swollen, spindle-shaped swellings on juniper twigs, branches, and trunks that are covered with orange gelatinuous masses during and following spring rains.

11. **Nectria canker**, caused by the fungus *Nectria galligena*, attacks a wide range of woody plants especially in northern areas with a maritime climate. Slowly enlarging, sunken or flattened areas of bark, usually centered around the base of a dead side shoot or wound, form on the twigs and branches. The girdling cankers slowly enlarge, becoming conspicuous and somewhat targetlike with the bark later sloughing off to expose concentric rings of callus. Small, bright red fungus fruiting bodies (perithecia), that later blacken, are clustered on the bark or wood at the margin of older cankers in autumn. When twigs and branches are encircled, the parts beyond the canker wilt and die.

Nectria twig blight, caused by a closely related fungus (*N. cinnabarina*), is cosmopolitan on hundreds of woody plants. It mostly occurs on dead wood but may be weakly parasitic. It produces small, sunken cankers that girdle and kill infected twigs. In mid to late summer, bright-pink or coral-red globular structures (sporodochia) form in the dead bark. Later, the pustules turn chocolate-brown. Both *Nectria* fungi overwinter in dead wood.

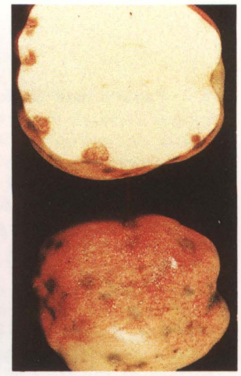
For chemical and cultural control suggestions consult the Extension Plant Pathologist at your land-grant university, or your county extension office.

Photo credits: K. T. Leath (1, 2, 3, 5R, 6L), University of Wisconsin (4, 6R, 8, 14), University of Illinois (5L, 9), USDA and Clemson University (7, 10), British Ministry of Agriculture (11), and M. C. Shurtleff (12, 13).

APPLE DISEASES II

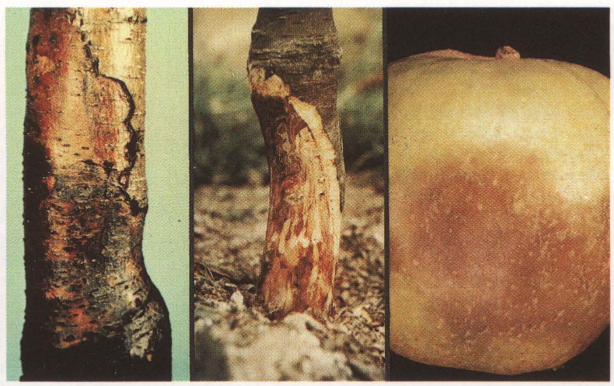
1. Papery bark canker

2. Botryosphaeria (Bot) rot

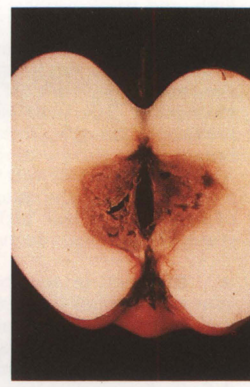


3. Bitter pit or Jonathan spot

4. Powdery mildew

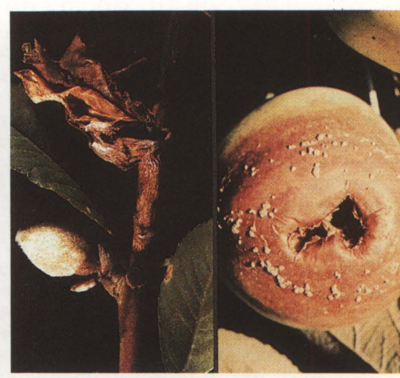


5. Phytophthora collar rot



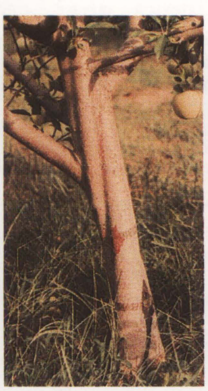
6. Water core

7. Fire blight



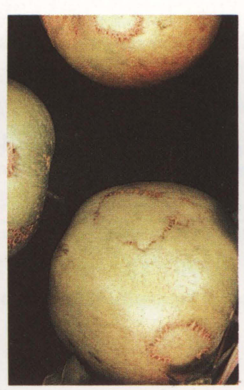
8. Brown rot

9. Apple mosaic



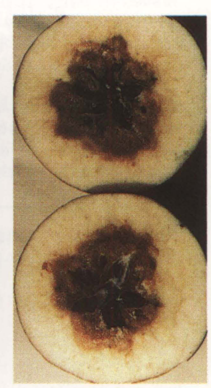
10. Trunk twisting and flattening

11. Russet-ring



12. Leaf pucker

13. 2,4-D injury



14. Brown heart or core

APPLE DISEASES II

1. **Papery bark canker**, commonly called **silver leaf**, is caused by the fungus *Stereum purpureum*. The fungus infects a wide variety of woody plants, including pome and stone fruits, in the northern states, being most prevalent following severe winters. The first symptom is usually the appearance of dull lead to silvery leaves on infected branches. Death of infected branches or the entire tree may occur within a year or two after the appearance of the silvered leaves. The fungus enters through wounds and produces a dark brown decay first of the heartwood, later killing the sapwood. The outer bark becomes "papery," splits, and sloughs off. Stunting of growth is often apparent before the tree dies. The characteristic, small (½ to about an inch in diameter), round, leathery, flattened to somewhat shelf-shaped sporophores of the causal fungus can often be found on limbs and trunks of dead trees. The upper surface of the fruiting body is velvety and buff or grayish in color; the spore-bearing under surface is purplish.

2. **Botryosphaeria (Bot) rot**, caused by the fungus *Botryosphaeria dothidea (B. ribis)*, infects a wide range of woody plants. Young twig, limb, and trunk cankers appear as blisters filled with liquid. The liquid spreads over the wood surface when the blisters rupture. Enlarging, sunken, dark colored cankers are soon evident. Dark, spore-producing structures (stromata) form on the canker surface. The following spring the canker may cork off and become inactive or may continue to grow. Mechanical injury or environmental stress (freeze injury, drought) predispose wood to infection. Fruit infections start as small, reddish-brown spots surrounding a lenticel. The fungus advances through the fruit forming a soft rot. The skin color fades to a light brown and then a deeper brown. Completely rotted fruits may often have syrupy beads of exudate on their surface. Fruit rot commonly starts to develop in storage. The fungus overwinters on living and dead limbs.

3. **Bitter pit or Jonathan spot** is a noninfectious disease that is most common in years when the fruit crop is light. Slightly sunken, circular, dark green spots with some internal browning form on the skin of the fruit. Later the spots may become deep red or light green; finally gray or black. As the fruit matures, the pits become more sunken with a definite brown corkiness of the flesh that may extend ¼ inch into the fruit. Bitter pit seems to be related to a fluctuating soil moisture supply associated with calcium nutrition, and is increased by abundant rainfall shortly before harvest. The disease is most severe on fruit picked immaturely; it increases in storage.

4. **Powdery mildew**, caused by the fungus, *Podosphaeria leucotricha*, overwinters mostly in terminal buds. A whitish, powdery to felt-like growth covers infected buds, blossoms, leaves, twigs, and fruit. The leaves are often stunted, narrower than normal, folded lengthwise, and become stiff and brittle with age. Twig growth is stunted and may have a witches'-broom appearance. Infected fruit commonly have a fine network of russeting, may be severely russeted, and sometimes are dwarfed. This disease is most common on certain cultivars in southern apple-growing areas.

5. **Phytophthora collar rot**, caused by the soil-borne fungus *Phytophthora cactorum*, infects a wide range of plants. Disease incidence has increased as dwarfing rootstocks (especially Malling-Merton or MM) have replaced seedling rootstocks. The fungus attacks the lower 30 inches of apple trunks, usually between the soil line and the crown roots. Infected bark becomes brown, somewhat depressed, and is often slimy when wet. A brown to reddish-brown discoloration of the wood and a gummy exudate under the dead bark is typical. The enlarging, definitely outlined cankers, girdle the lower trunk and/or roots and often result in death of the entire tree. A general lack of vigor, poor shoot growth, and formation of sparse leaves in summer, or reddish leaves in early autumn, is commonly the first indication of the disease. The *Phytophthora* fungus attacks the fruit of susceptible apple cultivars producing a firm, brownish rot. The disease is more common in heavy, poorly drained soils.

6. **Water core** is a noninfectious disease that occurs both in the orchard and in storage. The fruit must be cut open to observe the symptoms which arise in the core as a clear, "glassy" translucence that soon spreads to the surrounding flesh. Water core is most common in large mature fruits from sun-exposed portions of the tree. Fruits w
low calcium or high potassium and magnesium are most susceptible
water core.

7. **Fire blight** is an extremely destructive disease caused by the bac
rium *Erwinia amylovora*. Infected blossoms become water-soaked
appearance and soon wilt, turning brown to dark brown. Infec
shoots wilt from the tip, often forming a "shepherd's-crook," and
turn dark brown (as if scorched by fire). The disease may progress
the shoot from its base, blighting the lower tissues and girdling the
beyond. In young trees, the bacteria may girdle the trunk and kil
tree. The bark of invaded branches and scaffold limbs is darker
normal with the wood beneath turning brown. Later the mar
become sunken and often cracked, forming a definite canker. D
wet, humid weather, blighted tissues exude a milky, sticky ooze
soon turns brown.

8. **Brown rot** is caused by two closely related species of fungi, M
linia fructicola and *M. laxa*. The disease is usually a minor problem
the United States, but is much more important in Great Britain
continental Europe. In the U.S., the fungi infect apple fruits injured
insects, hail, birds, or other means. Mature apples develop soft,
brown spots that enlarge rapidly in warm weather. Entire fruits ma
destroyed within a day or two. Ash-gray tufts of mold develop on
surface of rotted fruits in damp weather. These fungi are much m
destructive to stone fruit trees where the blossoms, twigs and fruit
infected.

9. **Apple mosaic** is the most familiar viral disease of apple. The lea
on some twigs develop white-to-light yellow flecks, spots and blotc
and bands along the veins. Occasionally, mosaic may appear as light
dark green areas in the leaves. Severely infected leaves turn brown
drop early. Tree vigor and yield may be reduced. The virus is tra
mitted by budding, grafting and by root grafts between adjacent
"

10. **Trunk twisting and flattening**, believed by some to be caused
a virus, results in twisting and flattening of the trunk. Infected
are generally weak and vigor declines by the sixth year.

11. **Russet-ring** is a viral disease that is fairly common in certain
Affected Golden Delicious fruits develop narrow, irregularly c
rings to a solid circle of russet up to 1 to 2 inches in diameter. Ye
Newton apples develop elaborate networks of ring russeting, us
covering much of the fruit surface. Extensive, superficial, purp
brown blotches, without russeting, form on Stayman and Ju
fruits. Some cultivars are symptomless carriers (see also Leaf pu
below).

12. **Leaf pucker** may be part of a virus complex with russet-ring
fruit blotch. Foliage symptoms appear on the first-formed leave
early spring. Leaves on the fruit spurs appear dwarfed and pucke
and sometimes show yellowish-green flecking. Symptoms are ma
on leaves formed during hot weather. Fruit symptoms vary depen
on the variety, tree, and orchard and are described under Russet
The severity of leaf pucker and fruit russeting varies from season
season, depending largely on temperature. In cool summers se
russeting occurs; when summers are warm, no fruit symptoms oc
and only the first-formed leaves develop puckering and flecking.

13. **2,4-D injury** appears as a curling, twisting, and distortion of
leaves. Often there is a fern-leaf effect instead of normal foliage. Fo
nately, unless the dose (from spray drift, other air-borne particles
sprayer contamination) is too large, the plants gradually retur
normal.

14. **Brown heart or core** is a noninfectious disease that develop
storages that are excessively cold (below 36° F.). The core is
brown. Symptoms are not evident until the fruit are cut in half.

For chemical control suggestions, a listing of resistant vari
and other control measures, consult the Extension Plant Pathol
at your land-grant university, or your county extension office.

Photo credits: University of Wisconsin (1L), British Ministry of Agriculture (1R, 5C, 6, 12, 13), University of Illinois (2, 3, 7L, 8L, 10, 11), BASF
8R, 9), University of Missouri (5L), unknown (5R, 7R, 14), USDA and Clemson University (7 far L), S. V. Beer (7 far R).

APPLE

Malus sylvestris

Bitter Rot (fungus - Glomerella cingulata): Symptoms appear first as small, circular, brown spots on both apples and pears. The lesion enlarges and becomes saucer-shaped. The fungus overwinters in mummified fruit and cracks or crevices in bark. Most infections can be traced to a broken limb. Infection normally shows up in mid to late summer. Young fruit are resistant to the fungus. Maximum infection occurs at 85°F and after light rain. Orchard sanitation and a regular spray program are extremely important. Broken limbs should be cut to prevent overwintering of spores in these protected areas.

Black Rot (fungus - Physalospora obtusa): Black rot is a firm, textured rot. The spot is light brown and darkens with age. As it enlarges, it is marked with concentric dark bands. The lesion is convex in shape, yet in very advanced stages becomes somewhat depressed. On the leaf the lesion is a purple speck that enlarges and eventually has a center which is brown or yellowish-brown. The fungus infects foliage at petal fall. Fruit infection is not normally evident until midsummer. The disease is favored by temperatures of 80°F and light rain. Although fungicides help, sanitation is the best means of reducing this disease.

Powdery Mildew (fungus - Podosphaera leucotricha): Young foliage shows cupping and twisting. The leaves are covered with a white, powdery mass of spores. Net russetting will occur on fruit when it is infected with this fungus. All varieties are susceptible, yet Jonathan appears to be more susceptible than most. Use of a regular fungicide program will control this problem. Karathane, a commonly recommended fungicide, should not be used at temperatures of 90°F or above. A spreader should be used to improve control.

Sooty Blotch (fungus - Gloeodes pomigena): Sooty-gray or cloudy blotches appear on the fruit. The fungus attacks both apples and pears in Texas. It is most severe during years that have cool, wet springs, late summer rains, and low temperatures in early fall. It is normally found in conjunction with fly speck, another disease of apples and pears. Fungicides should be applied in late spring and early summer.

Fly Speck (fungus - Leptothyrium pomi): Numerous small, shiny, black spots are formed on the fruit. Control is the same as sooty blotch.

Apple Blotch (fungus - Phyllosticta solitaria): Shiny, black blotches develop on fruit. Edges of lesions are irregular with radiating outgrowths. Foliage symptoms are characterized by light gray spots with a dark dot in the center. Elongated, sunken, light colored lesions with black dots are formed on veins, midribs and petioles of the leaves. The spread of blotch is favored by temperatures of 75 to 80°F and heavy rains. Several fungicides will control this disease.

Cedar Apple Rust (fungus - Gymnosporangium juniperi-virginianae): The fungus passes part of its life on apple and part on the cedar. On cedar it forms reddish galls which swell and produce an orange slime each spring. On apple it causes spots on leaves, fruit and sometimes on young twigs.

The spots on the foliage and fruit are orange-yellow in color, and a blister or cushion forms in the center of each spot. Where this disease is a problem, cedars should be destroyed for 1 mile around an apple orchard. Normal spray programs will control infection on apples. Resistant varieties should be used when available. Golden Delicious and Delicious are resistant. Most ornamental crabapples and Jonathans are susceptible.

Quince Rust (fungus - Gymnosporangium clavipes): This fungus attacks both apple and pear. It attacks the blossom end of the fruit and restricts the growth of the apple. Tissue below the lesion dies and becomes spongy. Quince rust, like cedar apple rust, must complete part of its life cycle on cedar. Apple varieties susceptible to quince rust include Delicious types. Use fungicides and remove cedars in the area for control.

Fire Blight (bacterium - Erwinia amylovora): This bacterium causes twig dieback and is common on apples and pears as well as some 75 other plant species. Blossom blight is common on apples. Infected blossoms wilt and turn black rapidly. The foliage does not immediately abscise due to the rapid rate of death. Twig blight is common and can result in dieback ranging up to 12 to 36 inches of twig length. The bacteria overwinters in cankers. Bacteria oozes from the cankers in early spring and are carried by wind and insects to healthy foliage. Resistant varieties should be used when available. Fungicides containing copper will cause russetting on apples. Trees which have had fire blight should be pruned to remove overwintering cankers. Nitrogen levels should be kept low. No organic nitrogen sources should be used as they encourage continual growth which is susceptible to the bacterium. Make cuts from 4 to 6 inches below the visible cankers. All pruning equipment should be sterilized with a one part household bleach to nine parts water solution. For more information, refer to the pear section.

Phytophthora Collar Rot (fungus - Phytophthora cactorum): Black, slimy cankers are formed from the bud union to the lower portion of the trunk. Trees infected with this fungus are stunted and eventually die. It is particularly damaging on the Malling Merton Clones. Most seedlings of Delicious, Melba, McIntosh, and Wheatly are resistant. No chemical control recommended. See section on resistant varieties.

Bot Rot (fungus - Botryosphaeria ribis): The fungus infects woody tissues and fruits. Wounded apple wood is very susceptible. On limbs and twigs, infection is visible in July. It appears as a blister on the infected limbs. At maturity the blister ruptures and a liquid spreads over the limbs. The wet area then becomes sunken with a dark colored appearance. The spot spreads into the cambium where it enlarges in concentric rings until fall. Lesions stop enlarging in the fall and cracks appear along the edge of the spot. It may or may not begin growth next spring.

Fruit infection is observed as small reddish-brown spots. These eventually coalesce, causing a soft rot to occur. As the decay develops, the lesion turns light brown to dark brown and is covered with beads of exudate on the surface of the decayed fruit.

The fungus overwinters in live and dead limbs. In the spring, an ooze is formed which is spread over the tree. Mature and ripened fruit are very susceptible. The disease develops at temperatures of 75°F or above.

Botryosphaeria infection is encouraged by any condition which reduces tree vigor such as drought, winter injury, and low nutrition. Jagged pruning wounds and grafting sites are sometimes invaded. Pruning out the decayed areas and a thorough spray program will significantly reduce losses to this disease.

Scab (fungus - *Venturia inaequalis*): This fungus attacks both the foliage and the fruit. It first appears on the leaves as small, dull, smoky areas which with age become olive colored, velvety, and much more visible. On fruit, the lesions are first small, circular, olive green areas which turn dark and scabby. The spots crack open in late stages of development.

The fungus overwinters in fallen apple leaves. The fungus produces fruiting structures in the spring. Rains cause spores to be shot into the air where they are carried to developing foliage. The spore will germinate and produce a leaf spot if moisture is present when the spore lands on the leaf. Further spread occurs from these spots to adjoining leaves of fruit. Apple scab is dependent on moisture for development.

Crown Gall: (See section on Crown Gall.)

Chlorosis: (See section on iron deficiency.)

Mushroom Root Rot (fungus - *Armillaria mellea*): Mushroom root rot is caused by a soilborne fungus which attacks apples and causes a slow decline. Trees may be infected with the fungus for 2 to 3 years before death occurs. The vigor of the tree is noticeably reduced during this time. Trees infected with *Armillaria mellea* have a layer of creamy white fungal growth between the bark and the wood at the soil line. The growth (rhizomorphs) girdles the trunk and the tree dies when this girdling is complete. Trees damaged by the fungus can be diagnosed by the presence of the rhizomorphs and the advanced stage of decay of the root system. Infected trees are loose in the soil due to the deterioration of the root system.

Mushroom root rot is most often found in areas where post oaks were the predominate native timber and in sandy soils. This does not always hold true, and growers must be aware that the disease can cause serious losses in many soil types should it become established.

Soil fumigation will give only temporary control of this problem. The wide distribution of the fungus in the soil (both vertically and horizontally) and the constant recontamination of a fumigated area from nonfumigated soils reduce the early advantage gained by soil fumigation. Resistant root stocks are not available. Growers should avoid planting in areas where the fungus has been a problem in the past or on recently cleared post oak timberland.

It is best for a homeowner to move to another planting site should plants die from mushroom root rot.

Southern Blight (fungus - *Sclerotium rolfsii*): Infected trees die rapidly (2 to 3 weeks) after the first visible symptoms are observed. The leaves remain attached to the tree. Creamy white to yellow rhizomorphs are formed on the outside of the roots. As the growth develops, small, dark brown sclerotia are formed among the rhizomorphs. In Texas it has been observed attacking apple trees both in the nursery and in commercial orchards.

Currently, no chemicals are cleared for the control of Southern Blight on apples. Deep burial of organic material prior to planting and controlling weeds at the base of the tree will help reduce losses. Sclerotium rolfsii is a facultative saprophyte which grows on organic material in the soil, but under certain conditions, it can attack and parasitize healthy growing plants. Crop residue should be pulled away from the base of the apple trees.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Apples should never be planted in soil infected with this fungus due to its extreme susceptibility. See the separate section on Cotton Root Rot for more information.

AVOCADO

Persea americana

Anthracnose (fungus - Colletotrichum gloeosporioides): Black circular lesions appear on fruit. Spots vary from tiny spots to one-half inch or more in diameter. The center of the spots may be slightly sunken. Surfaces of larger spots frequently appear zonated and develop radial cracks. During moist periods, the spots show pinkish spore masses of the fungus. As the fruit ripens, the infection spreads rapidly into the flesh causing a greenish-black, fairly firm decay which eventually will involve a large portion of the fruit. Fruits from trees of Mexican cultivars which generally have very thin skin are more susceptible to anthracnose. Fungicide applications will reduce anthracnose infection with the first application made after bud swell and other applications made at two- to four- week intervals. Use of adapted varieties resistant to anthracnose will help reduce losses. Harvesting fruits in an immature condition appears to contribute to anthracnose development during storage and transit, especially when small bruises and skin breaks are present as the result of harvesting and packing.

Phytophthora Root Rot (fungus - Phytophthora cinnamomi): Some of the West Indian seedlings are affected by this fungus. Mature trees that have stood in water are more likely to become infected than trees in well drained areas. Infected trees have small leaves which are lighter green in color than healthy leaves; leaves wilt and drop, resulting in partial to complete defoliation. In advanced stages of the disease, twigs and branches die back, and fruit is small. Roots from infected trees are darkened, brittle, and many die. The fungus can be introduced or spread to new areas by movement of infested nursery stock and/or seed. Some control practices that reduce the spread of the disease are as follows: (1) use clean seed, do not allow fruits which are to be used for seed to come in contact with infested plant soil; (2) use clean nursery stock, only healthy, vigorous nursery stock, and discard wilted plants; (3) if the disease is located in an area, prevent movement of soil or water to non-infected areas; (4) plant on well drained soils and prevent water from standing under trees for prolonged periods of time.

Phytophthora Seedling Blight (fungus - Phytophthora palmivora): The disease is characterized by irregular reddish-brown spots that appear to have enlarged most rapidly along the larger veins. Lesions on young leaves are darker in color. As a result of the disease, the terminal bud of many seedlings dies. The disease is likely to appear on young seedlings during periods of heavy rainfall and high humidity, when seedlings are young and succulent. Providing good aeration in the nursery and spraying with copper fungicides will reduce losses caused by this fungus.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Avocado trees are reported as being susceptible to the cotton root rot fungus. However, few trees have actually been found affected by this disease. The fungus attacks very young trees, and trees become resistant with age. Infected trees wilt suddenly, leaves turn brown, and the trees die with leaves clinging to the branches. A white spore mat which later turns tan sometimes forms on the soil surface around diseased trees. There is no control of this disease once it becomes established. Avoid planting in soil known to be infested with cotton root rot.

Sunblotch (virus): Trees infected with sunblotch may show symptoms at any stage of growth. The disease may also be present in symptomless carriers, and it is only transmitted in budwood, graftwood, or seed from infected trees. Symptoms of sunblotch appear on twigs, limbs, and fruit. On twigs and limbs, the bark show white to yellowish streaks. The streaked areas are often depressed. Green fruits have characteristic white or yellow depressed areas usually extending into the fruit from the stem end. Infected fruits are badly marked and are small and misshapen. Control of the disease is by prevention. Trees should come from disease-free root stock and budwood. In the nursery, affected trees should be destroyed.

Leaf Burn (physiological): It is common to find damage on leaves of avocados grown under irrigation whether in orchards or in home landscapes. The tips and margins of the leaves die and turn brown. Burned leaves drop prematurely. This problem can be caused by accumulation of salts in the soil, inadequate soil moisture, strong dry winds and also by frost. Light irrigation should be avoided since this fails to leach salts accumulated in the soil. Proper irrigation and good drainage will reduce leaf burn.

BLACKBERRY, DEWBERRY, AND BOYSENBERRY

Rubus spp.

Orange Rust (fungus - Gymnoconia peckiana or Kunkelia nitens): The disease first appears as small, yellow spots on both sides of leaves. These spots enlarge on the underside to form irregular shaped pustules that rupture to release masses of orange spores. The fungus becomes systemic in plants, and affected plants never recover. Spread within the field is primarily caused by root grafting rather than wind-blown spores. Diseased plants including all roots should be removed and burned when first noticed and before pustules break open. Control weed growth to improve air drainage. Destroy wild brambles and dewberries in adjacent areas. Fungicides are not effective against this rust. Varieties vary in their susceptibility to this fungus.

Anthracnose (fungus - Elsinoe veneta): A common cane and foliage disease of blackberry and dewberry sometimes called dieback. The disease first appears in the spring as small purplish spots on new shoots and purple bordered spots on leaves. Spots on canes enlarge, usually develop an oval shape, and gradually turn gray. Ends of badly infected canes die back. Erect types are less susceptible than the more spreading types. Most effective chemical control is by spraying canes just before leaf buds open in the late winter followed by cover sprays at 10 to 14 day intervals. The number of cover sprays depends on the material used.

Septoria Leafspot (fungus - Mycosphaerella rubi): A fungus disease causing symptoms similar to anthracnose leafspots. Spots tend to remain small with light brown or tan centers. Tiny black specks visible with a hand lens develop in centers of leafspots. A similar leafspot without the black specks is caused by another fungus, Cercospora rubi. For control of leafspots, see Anthracnose.

Rosette (fungus - Cercosporella rubi): This disease is also called double blossom or witches' broom. Symptoms appear in the spring as bunches or clusters of foliage at terminals or along fruiting canes. Flower buds are larger and redder than normal. Petals may be purplish, and sepals are much elongated. Infected flowers do not set fruit. Control rosette by removing infected canes as soon as they become noticeable. Destroy all wild berry plants in the vicinity. Remove and burn all fruiting canes soon after harvest and keep plants adequately spaced for good air circulation. Where heavy infection has occurred, mowing all canes to the ground may be necessary. Fungicide sprays for anthracnose control may reduce rosette infection.

Yellow Rust (fungus - Kuehneola albida): A minor fungal disease sometimes called cane rust. Small, lemon-yellow pustules develop on canes and leaves throughout summer. Cracking and drying of canes and spotting and drying of leaves result. The disease is not systemic and does not affect blooming. Prune out and burn infected canes.

Powdery Mildew (fungus - Genus not determined): A fine, light colored powdery growth occurs on the foliage. Damage is minimal and does not require control.

Leaf Curl (virus): Foliage of affected plants is darker than normal, green, and wrinkled. Leaf edges tend to curl downward. Plants are smaller, weaker, and less productive. The disease has been noted most frequently on the Lawton blackberry in East Texas. Remove and destroy diseased plants.

Mosaic (virus): First symptoms are leaf mottling followed by bronzing and development of small, narrow leaves with down curled margins later in the season. Fruit is crumbly and insipid. Canes become shorter each year. Remove and destroy diseased plants.

Streak (virus): Young canes irregularly discolored with dots and vertical stripes of dark blue or purple tint. Tip leaves of young canes show a peculiar curling with midribs sharply hooked or recurved. Leaves curl downward sometimes rolling the leaf into a cylinder. Curling is most severe on younger leaves of rapidly growing parts. On year old infected plants, canes are short, and leaves occur close together sometimes developing rosette fashion. Remove and destroy affected plants.

Sterile Plant (virus): Common on blackberries and dewberries. Also known as nubbins, three-seeded, buckshot, and He-berry. Flower parts are dried, and fruit development is arrested. Poorly developed fruit may occur with normal fruit in the same cluster. Infected plants show an apparent increase in vigor and production of new canes. New canes are relatively small in diameter. Remove and destroy affected plants.

Cane Gall, Crown Gall, and Hairy Root (bacteria - Agrobacterium rubi, Agrobacterium tumefaciens, Agrobacterium rhizogenes): Cane galls are large, bark splitting swellings in long masses. Crown gall consists of large warty galls on roots or at base of canes. Where hairy root is involved, small wiry roots grow singly or in bunches from the main root or base of stem. Remove and destroy affected plants. Avoid replanting where diseased plants were removed. Examine nursery stock for evidence of galls and hairy root. Do not plant stock with galls or plants that have had galls removed.

Nematodes Other Than Root Knot (Xiphinema spp and others): Xiphinema or dagger nematode damage results in root swelling especially at the tips. Symptoms can be confused with root knot nematode damage as seen on other crops. Dwarfed fruiting canes and smaller fruit result. Damage is more severe on light sandy soil. Severe nematode damage can be avoided by planting clean root cuttings in soil where only grasses or small grains have been allowed to grow for three to four years. Commercial producers in problem areas may need to consider a pre-plant fumigant.

COMMON SWEET CHERRY

Prunus avium

Leafspot (fungus - Coccomyces hiemalis): This is the most common and most damaging leaf disease of cherries. It is most prevalent during rainy springs. The reddish spots drop out leaving circular holes in the leaves. With severe infection defoliation may follow the appearance of the "shot hole" symptom. This disease can be controlled with foliar fungicides.

Shot-hole or Black Leafspot (bacterium - Xanthomonas pruni): This bacterium also attacks peach and plum. The infected tissue dries up and falls out leaving a one-eighth inch diameter hole. It also causes a canker and gummosis of the stem. See the section on peach diseases for more detail.

Rust (fungus - Tranzschelia discolor): Rust also occurs on peach and plum. Yellow spots appear on the upper leaf surface with reddish pustules filled with spores on the lower surface. It can cause premature leaf drop lowering tree vigor. Apply fungicides in late summer and fall.

Bacterial Canker (bacterium - Psuedomonas syringae pv. syringae): This bacterium causes cankers, gummosis, and shoot blight. Sunken lesions appear in the spring with gummosis. Cracks and cankering follow resulting in a girdled stem. The foliage becomes yellow, curled, and withered. Wet spring weather can result in shoot blight and a small angular leafspot. This bacterium also attacks peaches. See the peach section for more detail.

Crown Gall (bacterium - Agrobacterium tumefaciens): Warty tissue masses or galls may form on the roots, at the root collar, or anywhere on the stem. No practical controls are available. See section on Crown Gall for more detail.

Black Knot (fungus - Apiosporina morbosum): Black knot is a very conspicuous and common disease that is also found on apricots and plums. Large, rough black galls form on the twigs. Twigs may die beyond the galls. No chemical control is recommended. Infected limbs should be removed.

Brown Rot (fungus - Monilinia fructicola and Monilinia laxa): These fungi cause blossom blight, twig blight, and fruit rot. See the section on Peaches - Brown Rot for more detail. Control by fungicide application and sanitation.

Witches' Broom (fungus - Taphrina cerasi): This fungus causes large numbers of irregular small branches to develop on twigs and larger branches forming a witches' broom. Blossoms develop and the leaves come out on the brooms earlier than on the normal branches. Large numbers of brooms may eventually kill a tree. Cut and burn brooms. Spray with fungicides in the fall or in early spring.

Mushroom Root Rot (fungus - Armillaria mellea): (See Mushroom Root Rot section.)

Cotton Root Rot (fungus - Phymatotrichum omnivorum): (See Cotton Root Rot section.)

Littleleaf: This is a condition in the West caused by a lack of zinc.

Little Cherry (virus): Fruit are half size. Flowering cherry acts as a reservoir for the virus. Buy only virus-free trees from reputable nurserymen and remove infected trees when they are discovered.

Necrotic Rusty Mottle (virus): Foliage and blossoms are delayed in the spring. Brown necrotic or rusty chlorotic spots develop on the leaves, often falling out to leave shot holes. Defoliation may occur. Buy virus-free trees from reputable nurserymen. Virus infected trees should be removed from the orchard.

Rugose Mosaic (virus): General chlorosis of the leaf occurs between mid-vein and margin with distortion. Fruit yield is reduced. The fruits become flattened and angular. Remove infected trees.

Rusty Mottle (virus): Many leaves turn bright yellow to red with green islands and drop before harvest. Those that remain have yellow-brown spots with a rusty appearance. The fruit is small, late, and tasteless. Remove diseased trees and select grafting material from virus-free trees.

Vein Clearing or Sweet Cherry Crinkle (probably genetic): A non-transmissible virus-like disease. Veins clear in localized areas or the entire leaf. Margins of the leaves are irregular. Some are elongated with slot-like perforations. Small blisters appear on lower sides of veins, and the upper sides are silvery. Leaves fold along midrib, wilt, and drop in midsummer. Some branches will rosette. Flowers are plentiful, but few will develop into fruit. The fruit will be pointed and flattened on one side with a swollen ridge.

CITRUS

Citrus spp.

Cotton Root Rot (fungus - *Phymatotrichum omnivorum*): The fungus attacks the underground parts of the citrus tree and occasionally kills young trees. Cotton root rot causes a sudden death of susceptible young trees with most of the dried leaves remaining temporarily attached to the branches. The best control for cotton root rot is to use a resistant rootstock such as sour orange.

Rio Grande Gummosis (various fungi suspected): This is one of several well-known gumming diseases of citrus. Gum formation on the trunk or branches is a characteristic symptom. Gum exudes from blisters containing gum pockets which are usually on the trunk. The wood beneath the blister shows a pink-orange color. Several factors such as freeze damage, high water table, salt accumulation, and poor cultural practices contribute to the disease. Gummosis is believed to be a condition of weak and injured trees that become predisposed to the disease; however, the disease has been reported to be infectious. No reliable cure exists for gummosis. Keeping trees in vigorous growing condition is the best way to avoid the problem.

Phytophthora Foot Rot (fungus - *Phytophthora* spp.): This disease, also known as brown rot gummosis, can affect the root system, the trunk below and above ground, branches, leaves, blossoms and fruits. It is especially troublesome during prolonged wet rainy periods. Foot rot is commonly found in Lower Rio Grande Valley orchards but becomes a serious problem under unusual circumstances such as after hurricanes. Infection of the trunk results in dark water-soaked areas in the active areas of infection. Often gum exudes profusely from active lesions. The dead bark frequently breaks away from the wood in vertical strips. Callus tissue begins to form on the margin of the surrounding heathy bark if the fungus becomes active again when conditions become favorable. If the lesion encircles the trunk, girdling occurs and results in death of the tree. Trees with the bud union beneath or close to the soil and trees in poorly drained locations are especially susceptible. *Phytophthora* also may attack nursery stock and young orchard trees during rainy weather. Symptoms of the disease which can be found by examining the crown are similar to those described for older trees.

Phytophthora foot rot can best be controlled using preventative practices such as the use of resistant rootstock and planting in well drained land. Sour orange is the most resistant rootstock for the Lower Rio Grande Valley. Less resistant rootstocks are tangelo and grapefruit, while lemon and sweet orange are highly susceptible to the disease. Seedlings should be budded at least five to six inches above ground level. Soil should not be thrown to the lower trunk, and wounds should be avoided. Soil fumigation with methyl bromide, used at the rate of four pounds per 100 square feet before establishing the seedbed, should control the disease in the nursery. A new product, Ridomil, has been cleared for use in seedbeds and has proven to be very effective.

Twig Dieback (various fungi): This can be caused by several fungi as well as by other factors. Fungal infection is often secondary, following freeze damage or damage resulting from mechanical or chemical injury. Affected young branches die back one or more inches from the tip, sometimes showing gum exudation. Damage by twig dieback usually is not severe.

Melanose (fungi - Phomopsis citri): Attacks all commercial varieties of citrus, but grapefruit is more susceptible than oranges. The fungus attacks only young tender twigs, leaves, and fruit, especially during periods of high humidity. Mature, hardened tissue is resistant to infection. Melanose symptoms on leaves first appear as small, circular, dark depressions with a yellow margin. Later the spots become raised and turn dark brown. Leaves turn yellow and may drop prematurely. Spots begin on twigs as on leaves, but they become more raised on twigs. In severe cases the twigs may die. Melanose spots on the fruit are at first small, light brown, and sunken; later they become dark and raised. When several spots are close together, the surface has a rough feeling to the touch, hence the name, sandpaper melanose. Spots sometimes develop into a tear streaked pattern, resulting from infection caused by spores washed down over the fruit surface by water drops during heavy dews or light rains. In other cases, large areas of the fruit surface crack in more or less irregular patterns, resulting in the "mud-cake" type of melanose. Abundant sporulation takes place in infected or dead tissue during periods of high humidity. Severe outbreaks of melanose can be traced to rainy periods occurring in the spring after spores have developed and before tissues have outgrown the susceptible stage. It is particularly bad in wet springs following a freeze which has resulted in an abundance of small dead twigs; citrus should be sprayed for melanose control in the first year following a freeze. Melanose is usually controlled by a single fungicide application after bloom or petal fall and before the fruit averages one-half inch in diameter. Under severe conditions, a second application may be needed.

Greasy Spot (fungus - Mycosphaerella horri): Caused by a weak parasite, greasy spot is strictly a leaf disease. The spots are yellow at first, then turn dark and appear slightly raised and greasy. With severe infection, leaves may turn yellow and drop prematurely. Fungal infection is favored by rust mite injury and humid weather. Control is obtained by spraying in the summer with neutral copper or oil.

Sooty Mold (fungi - Capnodium spp.): This is not a true disease because the several fungi associated with it do not feed on the tissues of citrus trees. Rather, the fungi feed on sugar rich honeydew excreted by insects such as aphids, brown soft scale, and whiteflies. The amount of sooty mold found is directly proportional to the number of honeydew secreting insects present. A heavy sooty mold coating on the fruit can result in a lower grade of fruit, and therefore, in an economic loss to the grower. When the leaf coating is heavy, it can interfere with photosynthesis and other physiological functions of the leaf. This could retard growth, cause light blooming, and reduce yields. Control measures are directed at insects which secrete honeydew, thus preventing the development of sooty mold fungi. Where sooty mold is heavy, one-half percent oil should be added to the insecticide spray.

Flyspeck (fungus - Leptothyrium pomi): This is caused by a fungus that keeps citrus fruit from turning yellow in the infected spots. The disease derives its name from the small black specks formed on the rind in areas immediately surrounding the oil glands. The contrast between green and yellow color lowers fruit grade, even though there is no effect on fruit or juice quality. Thus, it is of little consequence to fruit used for processing. No effective economic program has been developed for the control of flyspeck. Tests with fungicide sprays applied in the summer in some cases have increased the percentage of clean fruit.

Brown Rot (fungus - Phytophthora spp.): This is a fruit disease caused by the same species of Phytophthora that cause foot rot. The fungus can attack fruit on the tree during periods of excessive rain. Infection by the fungus results in decayed areas that are brown, firm, and leathery. At first the fungus cannot be observed on the fruit. Later a white, velvety growth is seen on the surface of the fruit, accompanied by a strong fermenting odor. Because the fungus is commonly found in the soil, fruits low on trees often are infected by rain-splashed soil. Winds can spread the actively growing fungus to fruit higher on the tree. Because brown rot is a wet weather disease, the fruit must be wet for some time before infection occurs. The best control for brown rot is sanitation during transit and in the packing house. Disinfecting the boxes is important. Treatment with disinfectant solutions and refrigeration are effective for prevention.

Stem End Decay (fungus - Diplodia natalensis): This is a disease of citrus fruit often found at the packing house or in transit. Decay occurs around the stem end and advances in streaks down the side of the fruit. There is no fungal growth on the surface of the fruit. Decay is reduced by dipping the fruit in fungicide solutions before placement in de-greening rooms. Promptness in handling and shipping, as well as refrigeration during transit, will help reduce losses caused by stem end decay.

Green Mold (fungus - Penicillium spp.): The fungus causes a rapid breakdown of fruit punctured or bruised during harvesting and packing operations. The fungus enters the fruit only through wounds. A white mold is first seen growing on the skin. The mold later turns green because of the large number of green spores produced. The decayed fruit becomes soft and shrinks in size. Losses from green mold can be reduced by taking precautions at harvest and in transit not to injure the fruit and by treating the fruit in the packing shed with a fungicide solution.

Virus Diseases: Four virus diseases occur on citrus in the Lower Rio Grande Valley: exocortis, xyloporosis, tristeza, and psorosis. The first three cause rootstock diseases, and psorosis causes bark shelling on the trunk and branches of trees eight to 10 years and older. These four viruses are bud-transmittable, and certain aphids can spread the tristeza virus. Damage caused by virus diseases varies with scion-rootstock combinations. Some viruses will result in only a slight growth slowdown. Others result in yield loss, severe stunting, decline, and eventual death. Because citrus viruses can be transmitted by budding, careful selection of budwood is an effective control method. Tolerant rootstock-scion combinations should be used if virus-free trees are not used. Citrus trees that have been certified to be tristeza and psorosis-free by the Texas Department of Agriculture are being used as a source of budwood by most Valley citrus nurseries.

Exocortis (virus): Causes bark-shelling and stunting of trees on trifoliate orange, trifoliate hybrids, and Rangpur lime rootstocks. In the early stages of the disease, gum exudes from pustules at the base of the trunk and may extend from below the soil line to the bud union. New bark forms beneath the pustules, and the outer bark sloughs off forming the characteristic bark-shelling. The rate of tree decline varies with tolerance to the exocortis virus. Some affected trees live for many years, while others die within two or three years. Sour oranges and Cleopatra mandarin rootstock are tolerant to exocortis. As long as sour orange remains the dominant rootstock in Valley orchards, exocortis will not be a major threat.

Psorosis (virus): Also known as scaly bark, this has been the most serious virus disease of mature citrus trees in Texas. This disease is spread chiefly by budding nursery stock with budwood from infected trees. Certain strains of psorosis, however, are capable of being transmitted through seed. Sweet orange, grapefruit, and tangerine are severely affected. Several strains of the psorosis virus have common leaf symptoms but different trunk and branch symptoms. Leaf symptoms are used to identify psorosis-infected nursery stock on young trees. This method of detection was used effectively in selecting psorosis-free budwood parent trees. Bark scaling of the trunk and larger branches is typical of psorosis symptoms in citrus trees eight to 12 years or older. The earliest bark symptom is scaling. As the disease progresses, the tree declines rapidly and eventually become unproductive. Psorosis is no longer a major problem in the Valley because most of the infected trees were removed after the 1951 freeze and replaced largely with psorosis-free trees.

Xyloporosis (virus): Affects many old-line commercial citrus varieties in the Lower Rio Grande Valley. Sour orange, the most common rootstock, is tolerant to the virus. No external symptoms are observed when sweet orange and grapefruit are infected. Orlando tangelo is highly susceptible. Infected varieties growing on tolerant rootstock are not affected by the virus. As long as sour orange remains the principal rootstock, xyloporosis is not considered to be a problem in Valley orchards.

Nematodes (nematode - Tylenchulus semipenetrans): Because the presence of the citrus nematode cannot be detected visually, positive diagnosis is based on external symptoms and laboratory examination of root and soil samples. Above-ground symptoms associated with nematode-infected trees are wilting, lack of vigor, poor fruit production, and poor response to watering and fertilization. The Texas Agricultural Extension Service operates a Plant Nematode Detection Laboratory where samples can be sent for analysis and recommendations. Local county Extension agents can assist growers in collecting and sending samples. Losses caused by the citrus nematode in heavily infected orchards can be reduced by applying chemicals to the soil. Before using chemicals, however, consider the overall condition of the orchard. Treating freeze-damaged orchards grown under poor cultural conditions may not be profitable. Soil should be sampled before establishing a new orchard to determine if parasitic nematodes are present in damaging numbers. Ideally, nematode-free plants should be used when establishing new orchards. For control in established orchards, see section on chemical control. At present, only two chemicals are labeled to use on citrus; both of these compounds are systemic, and both have an effect on the insect population.

Citrus Canker (bacteria - Xanthomonas campestris pathovar citri): Citrus canker is considered the most important bacterial disease of citrus worldwide, but is not found in the Lower Rio Grande Valley of Texas. It is highly contagious, being transmitted easily by infected nursery stock, budwood, leaves, twigs and fruit and even by wind-driven rain, insects, animals, people and contaminated equipment. Were any form of citrus canker to be found anywhere in Texas, its immediate and most damaging effect on the citrus industry would be the almost certain imposition of quarantines against the sale of Texas citrus fruit. These quarantine-related regulations would remain in effect until the disease was eradicated or until sufficient evidence was accumulated that its spread poses no threat to other areas. In either case, the marketing of Texas citrus would be seriously impaired for quite some time. Since the disease is presently found in Florida, Mexico, several countries in South America, Japan, South Africa, and countries in Asia, the introduction of citrus canker into Texas remains a possibility.

Lesions appear on leaves as small, round, blister-like eruptions, having at first a whitish color, but turning to tan or brown with age. A yellow halo commonly surround older lesions. As the lesion progresses, a water-soaked, oily area develops around the lesion. Lesions on the twigs are similar to those on leaves, but the areas affected are bigger. Raised, tan, necrotic tissue is commonly surrounded by oil, water-soaked margins. The most conspicuous symptoms are on the fruit. Although early infection results in symptoms similar to those found on leaves, blister and crater-type symptoms are more pronounced. Infection is usually confined to the surface of the fruit. Other disease-causing organisms may become established, causing severe fruit drop.

The most effective control practice for citrus canker is to prevent its introduction into an area known to be free of the disease. Quarantines have been effective in keeping canker out of certain areas. If the disease gains entrance into an area and is detected, its eradication must be attempted by all means. Failing to do so, other expensive and somewhat ineffective practices must be used, such as developing resistant varieties, using fungicidal sprays, taking advantage of certain cultural practices and using strict phytosanitary practices.

DATE PALM

Phoenix spp.

False Smut (fungus - Graphiola phoenicis): Small, black, wart-like bodies with yellow filaments protruding from the middle of the raised spots, occurring on both sides of the leaf. A very common disease of date palms in the South Texas area. No attempts are made to control the disease. Spraying with fungicides will protect the trees against infection.

Leafspots (fungi - Alternaria spp., Helminthosporium spp., Colletotrichum spp., Annellophora spp.): Spots are usually small, brown to black, some with light centers, occurring mainly on older leaves. Fruiting bodies of fungi may at times be seen in the diseased area. Chemical control is seldom required. Copper fungicides will protect against the disease.

Lethal Decline (mycoplasma - no scientific name): The disease affects date, coconut, and many other palms. The disease is first noticed when lower leaves turn yellow then brown and begin to droop. Later on, upper leaves begin to wilt, and finally, the entire top of the tree collapses. At the time, the tree has the characteristic symptom of a "closed umbrella." With time, all the dead leaves drop and only the trunk remains. Actually, the center or younger leaves die first but are unnoticed because of their location in the center of the crown. The mycoplasma destroys the growing tip of the tree which is located in the center of the crown right under the younger leaves. Once the growing tip is destroyed, no new leaves are formed, and the older ones die and drop off. The disease has been controlled in other areas by repeated injections into the trunk with oxytetracycline. However, treatment only results in remission of symptoms. If not repeated every three to four months, symptoms will reappear, and if treatment does not follow, the tree will die. Best control for this disease is the use of resistant palms, such as the Washingtonia robusta, Cocos plumosa and Phoenix roebelenii.

FIG

Ficus carica

Root Knot Nematodes (nematode - Meloidogyne spp.): Root knot is one of the most common disease problems occurring on figs. Infected roots are characterized by small galls or swellings on the roots. The presence of the galls on the roots interferes with the normal uptake of nutrients by the roots. Plants infested with root knot are stunted and have a general unhealthy appearance. Infested planting sites should be treated with Vapam prior to planting. This will reduce the nematodes in the soil to a low level. Do not use around living plants as it will result in severe root pruning, and in many cases death will occur. Make sure the fig plant is free of root knot. Once planted, the only practice left is to keep the plant in good health with regular fertilizer applications and maintain adequate moisture around the plant. If nematodes were initially present, the fig will eventually become infested, but the root system should be well established by then.

Fig Rust (fungus - Physopella fici): The disease is first evident as small, angular, yellow-green flecks on the leaf. The spots do not become extremely large but do become more yellow and finally a yellowish-brown. The margin of the spot is reddish in color. On the upper surface the spots are smooth, while on the lower surface the spots appear as small blisters. Brown spores are released from the blisters at maturity. As infection continues, the leaves become more yellow, and finally they begin to die around the leaf margins. Eventually death and defoliation occur. Complete defoliation can occur in two or three weeks. Fig rust generally becomes a problem as the fruit reaches maturity. Therefore, fungicide applications should be started in the early spring when the first leaves are completely grown. Make additional applications as new growth is formed. Do not spray when the fruit is one-fourth inch in diameter as the spray residue will make the fruit unattractive. Resume spraying after the fruit has been harvested.

Anthracnose (fungus - Glomerella cingulata): The fungus which causes anthracnose attacks both the fruit and the foliage. Infected fruit are characterized by a soft rot and premature dropping of the fruit. Immature fruit are dried up and may remain on the tree. Infection results in a small, sunken, discolored area. The areas enlarge with age and become covered with a pink mass of spores. Affected leaves will have a dark brown margin. Defoliation occurs with increased infection. Sanitation is extremely important in the fig planting. Diseased fruit as well as infected leaves should be removed.

Leaf Blight (fungus - Pellicularia kolerga): In early stages of infection, small areas in the leaves become yellow and appear watersoaked. With continual development, the upper surface becomes silvery white, and the lower surface becomes light brown and covered with a thin fungal web. In most cases, the leaves will turn brown and shrivel. It affects primarily the leaves but may develop on some fruit if it is new and a severely affected leaf or stem tip. Sanitation is the only recommendation to reduce losses from this disease.

Sclerotium Blight (fungus - Sclerotium rolfsii): A yellowish-white mat of fungal growth is formed at the base of the plant. Round, hard, yellowish to brown bodies (sclerotia) are found scattered in the fungal growth. To prevent the occurrence of this disease, it is important to carry out a thorough sanitation program. Old leaves or grass around the base of tree will encourage fungal development.

Limb Blight (fungus - Corticum salmonicolor): Affected limbs wilt rapidly. The fungus enters at a spot along the main or secondary limbs, and all leaves die beyond that point. The fungus enters at a dead fruiting spore or at some other injured spot. All dead twigs and limbs should be removed by pruning so that they will not serve as infection sites.

Souring (several fungi and bacteria): Organisms are carried into the fruit by the dried fruit beetle. Figs which have open "eyes" or ostioles should not be planted. Only those with closed "eyes" should be planted. Some examples of closed eye figs are Celest, Texas Everbearing, and Alma. No chemical control has been found to be totally effective. Maneb fungicide will help to some extent. Insects should be controlled to eliminate them as carriers for the disease causing organisms.

Fig Mosaic (virus): Affected figs show large yellow areas in the leaves, oak leaf pattern, ring spot area, or a mild mottled pattern. Leaves may be smaller than normal and deformed. Premature defoliation and fruit drop often occur. The virus is spread by vegetative cuttings and Aceria ficus (eriophyid mite). Control is by selection of clean propagating stock and insect control.

Dieback (physiological - cold injury): Fig trees are often injured by early or late frosts that kill younger twigs. Although their death is not related directly to loss in production, they may serve as a site for secondary fungi to get started. All dead twigs and limbs should be pruned from the trees.

Fruit Drop (physiological - flower development): The fig produces four types of flowers (male, female, Gall, and Mule): The male and female flowers are most often associated with the Capri type fig. This fig requires a wasp for pollination. The wasp does not occur in this part of the United States, thus it is impossible to grow Capri figs in Texas. Gall flowers are imperfect female flowers. They are found only on Capri and Cordelia figs. Mule flowers need no pollination and produce no seeds. The common fig grown in Texas produces primarily mule flowers. Since no seed are formed, the mule flowers are more subject to dropping than than those flowers which require pollination. The presence of the seed and the growth hormones produced by the seed help prevent fruit drop. The figs grown in Texas due to absence of seed are more subject to premature fruit drop as a result of adverse growing conditions.

Crown Gall: (See section on Crown Gall.)

Cotton Root Rot: (See section on Cotton Root Rot.)

Mushroom Root Rot: (See section on Mushroom Root Rot.)

FIG

Fig Varieties and Their Reaction to Souring

Variety	Reaction
Texas Everbearing	Resistant
Magnolia	Susceptible
Kodata	Susceptible
Celeste	Resistant
Alma	Resistant

[Blank Page in Original Bulletin]

GRAPE DISEASES I


1. Black rot


2. Macrophoma rot


3. Zonate leaf spot


4. Downy mildew


5. Powdery mildew


6. Ripe rot


7. Anthracnose

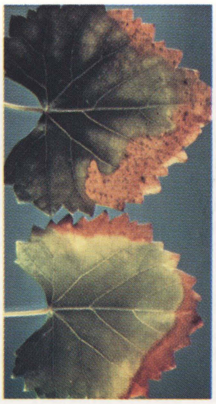

8. Bitter rot


9. Bunch rot


10. Yellow vein


11. Fanleaf


12. Magnesium deficiency


13. Marginal leaf burn


14. 2,4-D injury

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
COLLEGE OF AGRICULTURE
COOPERATIVE EXTENSION SERVICE
and VOCATIONAL AGRICULTURE SERVICE

FRUIT DISEASE NO. 8
OCTOBER 1983
URBANA, ILLINOIS

GRAPE DISEASES I

1. **Black rot**, caused by the fungus *Guignardia bidwellii*, is widespread and serious east of the Rocky Mountains, especially in warm, wet climates. Reddish-brown, circular-to-angular spots form on the upper leaf surface of American bunch grapes. Spots enlarge and merge to form irregular blotches with tannish-brown centers and a darker margin. Oval to elongated, depressed, purple-to-black lesions form on the shoots, leaf and fruit stems, and tendrils. A circular pale spot, soon surrounded by a brown ring, first appears on the green berry. The spots rapidly enlarge, become sunken, wrinkled, and dark. The berry turns into a coal-black, wrinkled mummy. Most diseased fruits usually "shell" or shatter, and drop early. On Muscadine grapes, fruit infections appear as dry, black, shallow, scabby spots. On very susceptible varieties, the spots may become large and crack open. Leaf infections enlarge to ¼ inch or more and become dark brown. Speck-sized black pycnidia occur on the surface of all older lesions. Spread occurs from all infected parts by spores which are disseminated primarily by air currents and rain splash.

2. **Macrophoma rot**, caused by the fungus *Botryosphaeria dothidea*, is a major disease of susceptible Muscadine grape varieties. The fungus is widespread and can be found on many cultivated and wild woody plants. Macrophoma rot starts as a small tan-to-brown spot which may have some fungus spore-producing structures (pycnidia) in the center. A water-soaked, light brown rot spreads from the spot and consumes the entire berry. This disease suddenly attacks the fruit as it matures and spreads rapidly during the ripening period.

3. **Zonate leaf spot**, caused by the fungus *Cristulariella pyramidalis*, first appears as yellowish-gray or yellowish-tan spots with a dark brown margin. Later, the lesions enlarge, may merge, and develop a series of brown concentric rings giving a target-like appearance. The lesions may merge to form large diseased areas. With a reading glass or hand lens, minute, white-to-tan "christmas trees" (propagules) may be evident in the whitish centers of older lesions. The fungus may cause premature defoliation of grapes and a wide range of woody and herbaceous plants in the Eastern and Central United States. The disease appears under unusually damp conditions where air circulation is poor and widely fluctuating temperatures occur.

4. **Downy mildew**, caused by the fungus *Plasmopara viticola*, is a serious disease in cool and humid areas east of the Rocky Mountains. Irregular, pale yellow to greenish-yellow spots, that may merge and later turn dark reddish-brown, appear on the upper surface of older leaves. A dense, whitish downy mildew growth appears on the corresponding underleaf surface following humid weather. Affected leaves eventually turn brown, curl, and drop early exposing the immature berries to sunscald. Young infected berries become soft, light brown, and are frequently covered with a white downy growth when damp. Berries infected later turn dull green, then dark brown to brownish-purple, wrinkle somewhat, and shatter easily. The whitish mildew is common on shoots and tendrils. Young shoots are often stunted, thickened, and quite distorted. The fungus overwinters primarily in fallen leaves. Dissemination is by wind, rain splash, and by handling wet plants.

5. **Powdery mildew**, caused by the fungus *Uncinula necator*, occurs generally on certain susceptible varieties during warm, dry periods. Leaves, young shoots, tendrils, and fruits are covered with superficial, white to grayish, powdery patches of mildew. The berries commonly appear russeted, fail to mature properly, and may split. Some berry drop or reduction in berry size may also occur. When severe, leaves become curled, scorched, and fall early. The fungus overwinters on affected plant parts.

6. **Ripe rot**, caused by the fungus *Glomerella cingulata*, is an important disease in the South during wet seasons. The disease suddenly appears on ripening berries and spreads rapidly. Lesions may develop concentric zones. Initially, the symptoms are very similar to bitter rot. Fungus spore-producing bodies (acervuli) form on the surface of decayed berries and release large numbers of pinkish to rusty-red spores (conidia) during wet periods. The pink to rusty-red appearance is unique to ripe rot. As the berries become completely decayed, they shrivel into mummies. The fungus overwinters in decayed fruit and on a wide variety of cultivated and wild plants.

7. **Anthracnose**, caused by the fungus *Elsinoë ampelina*, is widespread on susceptible varieties of American bunch grapes. Enlarging, sunken, ash-gray spots with a dark reddish-brown border (bird's-eyes) form on the fruit. Similar spots appear on young shoots, tendrils, fruit stems, petioles, and leaf veins. When severe, leaves may curl downward. Leaf spots often drop out causing the leaves to appear ragged. Shoot lesions may merge and girdle the stems, causing dwarfing and death of the tips. The fungus overwinters on infected canes. Spores (conidia) spread to new growth by rain splash.

8. **Bitter rot**, caused by the fungus *Melanconium fuligineum*, is most common and serious in the South during wet season. Fruit approaching maturity develop water-soaked spots; the berry is soon consumed by a soft rot which has a burnt-bitter taste. Numerous, elevated, black fungus spore-producing structures (acervuli) develop on the rotted areas. Decayed berries, which shrivel into 'dry mummies, become nearly covered with the irregular black acervuli. The fungus overwinters on mummified berries and stem lesions.

9. **Bunch rot**, caused by the cosmopolitan fungus *Botrytis cinerea*, attacks a wide variety of plants. It is common on soft ripe berries of certain grape varieties. Infections generally start on fruits that have been injured. Affected berries become soft, watery, and usually develop a dense, dusty gray mold. The fungus overwinters on diseased plant parts; dissemination is by wind-borne spores (conidia).

10. **Yellow vein** or grape decline is caused by strains of the tomato ringspot virus. Symptoms are variable depending on the variety and virus strain. Vines decline in vigor and productivity and may winter-kill. Infected canes are often smaller in diameter with short internodes and increasingly rosetted toward the tips. Leaves are diffusely mottled, chlorotic, dwarfed, and may develop characteristic bright yellow bands along the main veins. Fruit set may be reduced. The soil-borne virus is transmitted from plant to plant by dagger nematodes. Once infected, a vine cannot be cured. All cuttings taken from a diseased vine are infected.

11. **Fanleaf** is caused by a soil-borne virus. Symptoms tend to disappear during the season and differ greatly dependent on the variety, plant vigor, and season. New growth is severely stunted with short internodes arranged in a zigzag fashion, double or treble nodes, and dwarfed, mottled, puckered, or rough and pitted leaves. The leaves on some varieties are deeply lobed and may resemble a half-closed fan. Shelling of flowers is common resulting in a poor fruit set. Vines decline in vigor and gradually die. The virus is transmitted by nematodes and planting infected cuttings. Once diseased, a vine cannot be cured.

12. **Magnesium deficiency** appears as a progressive yellowing of the leaf margins and interveinal areas, starting with the older basal leaves. The yellowing may progress to younger leaves and, if severe, may develop into extensive dead areas between the veins. Leaves are sometimes puckered. Magnesium deficiency is most common in very acid soils (below pH 5.0) that lack magnesium rock, where the soil is extensively leached from heavy rainfall or is sandy, where dolomitic limestone is lacking, or where excessive amounts of potash have been used.

13. **Marginal leaf burn**, resulting in a scorching of the leaf margins and tips, may be caused by a fungus disease and/or injury to the roots, trunk, or canes, a virus infection, prolonged drought, air pollution (fluorine injury), high nematode populations in the soil and roots, salt injury, potassium deficiency, pesticity toxicity, and possibly other causes.

14. **2,4-D injury** results from spray drift or fumes or from using equipment that has previously applied 2,4-D. Affected leaves are small, stiff, fan-shaped with close yellow veins, and many sawtooth edges. Shoot tips are most easily and severely affected; terminal growth may cease or be retarded for several weeks, Fruits ripen unevenly, if at all. The effects of delayed fruit maturity may exist for one to three years before normal ripening occurs.

For cultural and chemical control suggestions, a listing of resistant varieties and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county Extension office.

J. R. Hartman (1L, 3), University of Illinois (1LC, 4L), USDA and Clemson University (1C and RC, 7C and R, 8R), R. K. Jones (1R, 2, 5R, 6, 7L, 8L, 12, 13), M. C. Shurtleff (4R, 10, 11, 14R), C. T. Schiller (5L), BASF (9), Purdue University (14L).

GRAPE

Vitis vinifera

Black Rot (fungus - Guignardia bidwellii): Black rot shows up as small, reddish-brown spots on the upper leaf surface. In older lesions the margin is a black line while the inner area of the spot is brown. Small, black dots are also visible in the center of the lesion. Infected fruit shrink until they are dried mummies. The first stage of development on the fruit is small, light-colored lesions with black borders. In advanced stages the fruit is marked with the small, black dots just like the foliage. Young grape foliage is most susceptible to this disease. Disease development is favored by high temperatures and humidity. A rainy period followed by two to three days of foggy weather favors development of this disease. Preventative fungicides along with resistant varieties should be used to control black rot.

Downy Mildew (fungus - Plasmopara viticola): Downy mildew is common in cool, humid environments but seldom occurs in hot, dry areas. Downy mildew is first observed as a pale yellow area on the upper surface of the leaf. The underside of the leaf is marked by a downy appearance. As the disease advances the infected tissue dies and turns brown. Young stems become thickened and are often covered with the white fruiting structures. Fruit that is infected is covered with the white growth or it turns the berry a dull green and then brown. Downy mildew is a particular problem in areas of high humidity. The disease develops in temperatures of 50 to 60°F. Some American grape varieties show resistance, but additional chemical protection is usually needed. Most European varieties are very susceptible. Fungicide application should begin before bloom and continue at seven day intervals.

Powdery Mildew (fungus - Uncinula necator): This fungus grows on all aboveground parts of the vine. Powdery mildew causes curling and withering of young leaves and dark staining on the surface of mature leaves. It may appear as a gray powdery growth on canes, and when rubbed off, it leaves web-like, dark-brown discolorations. Other symptoms include dropping, discoloration or splitting of berries, browning, and poor maturation of canes. American grape varieties are rarely damaged by this disease. Since the fungus is favored by low humidity and can grow at 90°F., this disease is more common in West Texas. Prevention is the best means to control powdery mildew. It should be controlled by fungicides applied when foliage first develops and repeated at two to three week intervals until berries are full size. If newer fungicides are not available, sulfur dust applied at the rate of 5 to 10 pounds of dusting sulfur per acre will prevent powdery mildew from developing. Apply dust when shoots average 6, 12, and 18 inches in length. Make additional applications every two weeks until fruit matures. Reapply sulfur after rains. If early sprays are omitted, heavy infections can be controlled with wettable sulfur at 1.5 pounds/100 gallons with a wetting agent. Do not spray table grapes with this mixture if berries are more than one-third full size. Sulfur dust or spray can burn leaves, shoots, and fruit when the temperature is over 90° F.; no applications should be made at such times.

Anthracnose (fungus - Elsinoe ampelina): This disease is often called "birds-eye-rot" because of the circular, sunken, ashy gray, dark-bordered spots on the berries. It attacks fruit stems, leaf veins, petioles, tendrils, and young shoots in addition to the berries. The berry often cracks to the extent of exposing the seed. The disease overwinters in old lesions. Periods of high humidity favor disease development. Fungicides used for black rot will help prevent this problem.

Dead Arm (fungus - Eutypa armeniacae): This fungus invades grape tissue slowly. Spring symptoms on developing shoots and leaves adjacent to an infected pruning stub may not appear for four to five years. Cankers form on vines, and nearby leaves become chlorotic and dwarfed. Cordons die later, producing the "dead arm" symptom.

Pierce's Disease (bacterium - rickettsia-like): Early summer symptoms include delayed shoot growth, leaf mottling, and dwarfing of new shoots. Late summer and fall symptoms are burning, scalding, or drying of leaves; wilting or premature coloring of fruit; and uneven cane maturity. Ribier is very susceptible, usually dying within two years. Thompson seedless and most other French (Vinifera) varieties die within two to five years. American (Lambrusca) varieties often live longer than five years. No effective control is known. Pierce's disease is spread by several types of leafhoppers, by the spittlebug, and by grafting. Seventy-three plant species serve as disease reservoirs and hosts for these vectors.

Grapevine Fanleaf (virus): Fanleaf is caused by a virus that also causes yellow mosaic and veinbanding. All three are transmitted by the nematode Xiphinema index. Leaf symptoms that resemble a fan are very conspicuous on Mission and French Colombard. Infected vines have shortened and more irregular internodes. Lateral sprout development, double nodes, and stem faciations cause a bushy appearance. Many berries shatter, and others do not develop beyond shot size. Diseased vines should be removed.

Leaf Roll (virus): Leaves roll downward and turn red between the veins progressing toward the cane tips. In California, symptoms appear in early June in non-irrigated vineyards and in August in irrigated vineyards. Vines have fewer, smaller clusters per vine with berries that are low in sugar. Red fruit varieties, such as cardinal and Mission, develop fruit lacking color, and berries of white grapes, such as Thompson seedless and Reisling, develop a yellowish-white color instead of the normal greenish-white. In general, leaf roll decreases fruit color, raises the acidity, and delays ripening. The disease is spread by propagation from infected mother vines.

Vein Clearing (virus): Yellowing along the leaf veins.

Crown Gall (bacterium - Agrobacterium tumefaciens): Crown gall is caused by soil-inhibiting bacteria. The bacterium often enters wounds caused by freeze injury or hail. It stimulates the cells in the plant tissues to grow rapidly, resulting in the formation of tumor-like, spongy overgrowths which develop around the crown of the plant. Rain can splash bacteria onto the aerial parts of the vine where the tumors are often called black knots. The pathogen can move in the vessels and spread throughout the vine. Sanitation is the best prevention. Avoid cutting into affected tissue when pruning. Chemical and biological controls are now available.

Cotton Root Rot: (See Cotton Root Rot section.)

Root Knot: (See Root Knot Nematode section.)

Mushroom Root Rot: (See section on Mushroom Root Rot.)

Chlorosis: Chlorosis in grapes is usually caused by iron deficiency. American varieties are particularly prone to have this problem. The leaves turn yellow, but the veins remain green. If not remedied, chlorosis will decrease the yield, reduce sugar content of the fruit, and eventually kill the vine. Two applications of iron sulfate or iron chelate during the growing season should control chlorosis. In high pH soils, iron sulfate and some iron chelate may become tied up and unavailable to the plant. Foliar applications can be made, or a chelate especially for alkaline and calcareous soils, such as Sequestrene 138Fe, can be used.

GRAPE

General Disease Resistance

According to Texas A&M University tests at Lubbock, American grapes (*Vitis labrusca*) and French hybrid grapes exhibit general disease resistance. The French grape (*Vitis vinifera*) has the greatest disease susceptibility. Muscadine grapes (genus *Muscadinia*), native to the United States, are resistant to most diseases.

Grape Rootstock

Champanel

Root resistant to:	Root Knot Nematodes Cotton Root Rot
Foliage and fruit resistance to:	Black Rot

Dogdridge

Root resistant to:	Root Knot Nematodes Cotton Root Rot

Corderc 1613

Disease resistance unknown but produced superior yields at Lubbock.

Reaction to Black Rot

Thompson Seedless:	Very Susceptible
French and American Hybrids:	Very Susceptible
American Varieties:	Resistant

Reaction to Powdery Mildew

Concord	Susceptible
Chenin Blanc	Very Susceptible
Emerald Riesling	Very Susceptible

White Riesling	Very Susceptible
Helena	Very Suceptible
Zinfandel	Very Susceptible
Ruby Seedless	Very Susceptible
Thompson Seedless	Very Susceptible

LOQUAT

Eriobotrya japonica

Fire Blight (bacterium - *Erwinia amylovora*): Loquat is a member of the family Roseaceae and is related to apple, pear, and quince. Fire blight, as described under pear, is the most serious disease of loquat.

Cotton Root Rot (fungus - *Phymatotrichum omnivorum*): See section under cotton root rot.

Mushroom Root Rot (fungi): See section under root knot nematode.

Root Knot (nematode): See section under root knot nematode.

[Blank Page in Original Bulletin]

PEACH DISEASES

An Aid to Identification and Control

1. PEACH DISEASE PROBLEM

2. BLAST ON LOWER TRUNK

3. ROOT ROT

4. SCAB ON FRUIT

5. BACTERIAL SPOT ON FRUIT

6. BROWN ROT ON FRUIT

7. SCAB ON TWIG

8. BACTERIAL LEAF SPOT

9. BROWN ROT BLOSSOM BLIGHT

PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

[Blank Page in Original Bulletin]

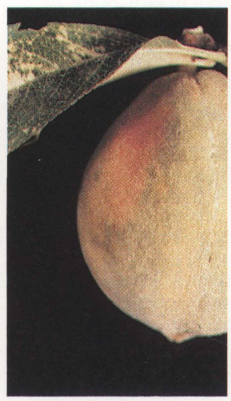
PEACH DISEASES II


1. Rosette


2. X-Disease


3. Yellows


4. Stem-pitting


5. Calico


6. Iron (Fe) deficiency


7. Manganese (Mn) deficiency


8. Clitocybe root rot

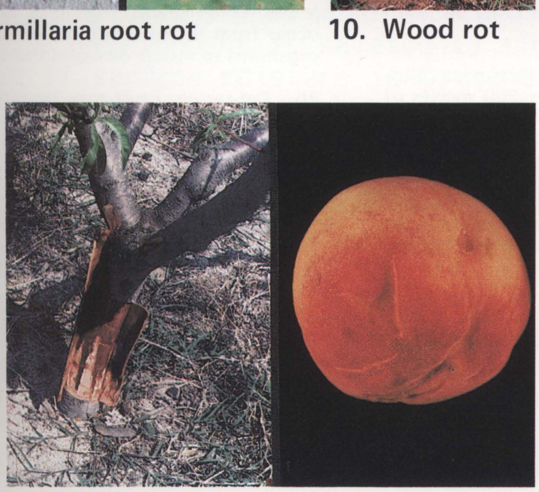

9. Armillaria root rot

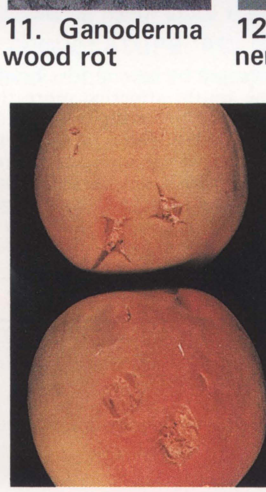

10. Wood rot


11. Ganoderma wood rot


12. Root-knot nematode


13. Frost crack


14. Cold injury


15. Hail injury


16. Cat-facing

PEACH DISEASES II

1. **Rosette** is caused by an agent that spreads from wild plums to commercial plums and peaches. Leaves on part or all of a tree are yellow and folded inward or arched backward. New shoots have very short internodes with leaves appressed into rosettes. Leaves on older parts of a tree turn yellow and drop early, leaving tufts of green leaves near the tips of the shoots. Affected branches rarely set fruit. A tree may leaf out the following spring but dies quickly.

2. **X-Disease**, caused by a mycoplasma, appears 6 to 8 weeks after growth commences. Leaves on isolated branches tend to roll upward longitudinally and develop irregular, yellow to reddish-purple blotches that drop out, leaving them tattered. Older leaves drop prematurely leaving tufts of small green leaves at the tips of infected shoots. Most fruit on affected branches shrivel and drop prematurely. The disease is worst where chokecherries are close by. Transmission is by leafhoppers as they feed.

3. **Yellows**, a mycoplasmal disease, causes leaf and flower buds to unfold prematurely. Clusters of slender, erect shoots on the scaffold limbs and trunk give the tree a bushy appearance. Leaves on these shoots are small, narrow, yellowish, red-spotted, roll inward, tend to droop, and drop early. Twigs and branches later die back. Trees die within 2 to 6 years after onset of symptoms. Fruit mature several days to 3 weeks early, may be larger than normal, but are of poor quality with an insipid or bitter taste. Transmission is by budding or grafting and the plum leafhopper.

4. **Stem-pitting** of stone fruits, caused by strains of tomato ringspot virus is transmitted in soil by a dagger nematode (*Xiphinema*) and by diseased nursery stock. Trees appear as if girdled. Shoot growth is stunted. Leaves roll upward lengthwise, droop, become progressively more yellow, often reddish to purplish in later summer, and drop early. The trunk becomes enlarged at ground level and below with a thick spongy bark. Shallow to deep vertical pits, grooves, furrows, and ridges form under the bark. Trees often have poorly anchored root systems with decayed feeder roots. Young trees tend to break over easily. Fruits ripen prematurely, have poor flavor, are often small, misshapen, more deeply colored than normal, and drop prematurely.

5. **Calico**, caused by a virus, occurs in the western U.S. A pale-green, yellow, cream, and white mosaic is evident as the leaves unfold. The pale-green areas later change to creamy-yellow and papery-white. When extreme, all or most of some leaves may lack any green; later turn brown at the margins. Affected fruit develop irregular creamy-white or bleached areas that turn orange or reddish at maturity, are smaller and more nearly round than normal fruit. Transmission is by grafting and planting infected nursery stock.

6. **Iron (Fe) deficiency** appears as a paling of green in leaves. The interveinal areas become bright yellow and, if not corrected, the leaf turns ivory color with brown margins. When severe, chlorotic leaves are smaller than normal and twigs and small branches die back from the tips. Young leaves that emerge are chlorotic; mature leaves do not become chlorotic.

7. **Manganese (Mn) deficiency** usually appears in full size leaves and is more pronounced on older leaves. Tissue along the midrib and main veins remains green to yellow. When severe, shoot growth is dwarfed and the leaves develop dead spots which fall away resulting in "shot-holes."

8. **Clitocybe root rot**, caused by several species of the fungus *Clitocybe*, is widespread in the south, affecting more than 200 species of woody plants. Trees lose vigor, gradually decline, and die from root decay. The leaves remain stunted and sparse, often turn yellow and drop early. Clusters of tan to honey-colored mushrooms (very similar to those of *Armillaria*) often form in the fall at the base of a tree. White mycelial fans form between the bark and wood (also similar to *Armillaria*), but the black, shoestring-like rhizomorphs are lacking. Like *Armillaria*, *Clitocybe* is most prevalent on land cleared of hardwoods and in sandy soils subject to drought.

9. **Armillaria root rot**, caused by the fungus *Armillaria (Armillariella) mellea* is cosmopolitan. Trees form small, yellowish leaves that redden early in the fall. Shoot growth is reduced; later the twigs and branches die back and the tree dies. Trees often die in a roughly circular pattern from a central point. Dense, white, fan-shaped fungal growth is evident throughout dead tissue. Branched, dark brown to black "shoestrings" (rhizomorphs) grow over diseased areas. Honey-colored mushrooms commonly spring up at the trunk base in late fall. Spread from tree to tree occurs by rhizomorphs growing through the soil. The fungus attacks a wide range of plants.

10. **Wood rot** is cosmopolitan and caused by numerous different fungi. Decay develops slowly over a period of years, and may not noticeably shorten a tree's life. Most decay is confined to the heartwood. Trees may slowly decline in vigor, twigs and branches die back, and become structurally weak. The fungi usually produce conks (sporophores) of the bracket or shelf, hoof, or mushroom type. Invasion occurs through pruning cuts, branch stubs, and a wide variety of other injuries to the bark of branches or trunk where wood is exposed.

11. **Ganoderma wood rot**, caused by the fungus *Ganoderma applanatum (Fomes applanatus)* results in a mottled, white root and butt of many hardwoods. The fungus invades bark wounds and destroys the heartwood. At first, the wood is somewhat bleached and surrounded by a dark brown band. The upper surface of the fruiting body (or conk) is smooth, zoned, gray or gray-black, and up to 2 feet wide. The white undersurface turns brown when bruised. Microscopic spores are released by the millions from the undersurface of the conk and are airborne to bark wounds.

12. **Root-knot nematodes**, caused by species of *Meloidogyne*, attack more than 2000 species of plants. Infected trees are often stunted, lack vigor, the foliage is pale green or yellowish, tends to wilt on hot days but recover at night, and defoliates early. Trees often exhibit twig and branch die back and are more susceptible to winter injury. Fruiting is reduced. Round, spindle-shaped, or irregular galls and swellings ("knots") form in the discolored roots which often decay. Injury is most severe in light-textured soils low in nutrients and organic matter.

13. **Frost crack**. Trees in exposed, dry, sunny and windy locations or in poorly drained soils may be injured by rapid drops in temperature following periods of mild weather. Trees overfed with high-nitrogen fertilizer and actively growing in late fall, are commonly injured. Frost crack, a vertical separation of bark and wood, is common on the south or southwest sides of the trunk. The cracks often reopen each winter, providing entry for disease-causing organisms and insects.

14. **Cold injury**. Fruit buds are injured or killed. Open blossoms are killed at 25°F or below with small fruits increasingly more tender to ½ inch long. Cold-damaged fruits are wrinkled, furrowed, and malformed. Twigs, limbs, or entire trees may wilt and die due to low winter temperatures. Affected sapwood is often dark brown to black. Discolored cankers (sunscald) on exposed limbs or base of the trunk and injured or dead roots are other forms of winter injury. Damage is most common where trees are not well adapted.

15. **Hail injury**. Hailstones produce bruises and cuts (often split at the edges) in fruits, twigs, and small branches. Ragged holes appear in leaves. When severe, trees may be nearly stripped of foliage. Injuries occur from the direction the hailstones strick and allow disease-causing organisms to invade damaged tissues.

16. **Cat-facing**. Fruit may be pitted, dimpled, scarred, and distorted, from the feeding of sucking insects (tarnished plant bug and stinkbug), damage by the plum curculio, or frost. Injury occurs when fruit are small.

For cultural and chemical control suggestions, a listing of resistant varieties and other control measures, consult the Extension Plant Pathologist at your land-grant university or your county Extension office.

Photo credits: D. F. Ritchie (1L, 4C and R, 8, 11, 12, 14L, 16), C. N. Clayton (1R, 14R), T. M. Sjulin (2L and R, 13), unknown (2C), Purdue University (3), M. C. Shurtleff (4L, 7, 10), University of Illinois (5, 15), California Department of Agriculture (6), University of Wisconsin (9L), H. A. Lamey (9R).

PEACH, APRICOT AND NECTARINE

Prunus spp.

Bacterial Canker (bacterium - *Pseudomonas syringae*): Elongated cankers develop at the base of buds and randomly on the trunk and scaffold limbs and are most prominent during late summer and fall. Damaged areas are slightly sunken and somewhat darker in color than the surrounding bark. At both the upper and lower margins of the canker, narrow brown streaks extend into the normal tissue. As the trees break dormancy in the spring, gum is formed by the surrounding tissue and may exert enough pressure to break through the bark and flow. The area beneath the canker has a soured odor.

Cankers start developing in the fall at the base of a bud or at a wound and increase in size during the winter becoming visible in early spring. If infection takes place early in the fall, the area is walled off by callous tissue and cankers are not produced.

The bacterium is a rather weak pathogen and causes serious damage only when a tree is in a dormant condition or weakened due to unfavorable growing conditions. The bacterium is spread by wind, rain, and nearby infected buds, leaf scars, and other wounded areas. It is felt that much of the movement of this disease is through diseased nursery stock. Selection of clean nursery stock helps reduce inoculum from being introduced into an area.

Avoid using high nitrogen fertilizer rates in the late spring or early summer. Trees should enter dormancy normally rather than encouraging late fall growth which is more easily infected at abscission time. Prune when the trees are fully dormant (January and February). Trees pruned early in the year prior to dormancy can be infected with the bacterium carried on pruning shears. Trees showing signs of bacterial canker should be left and pruned after healthy trees have been completed. Early pruning encourages late fall growth of trees which are more susceptible to the bacterium. Infection most often occurs in the fall. Trees should be sprayed with a copper-containing fungicide at leaf drop.

Peach Leaf Curl (fungus - *Taphrina deformans*): The peach leaf curl fungus is found in all areas. It affects leaves, flowers, tender shoots and fruits. Infected leaves are characterized by puckering, thickening and curling. Diseased leaves become pale yellow to light green and shed after a short time. On young twigs, the disease appears as small, seldom-noticed swellings. Fruit and blossoms shed when infected and are seldom observed by growers. Disease development is related to air temperature at the time buds are opening. If surface moisture is present and the air temperature is near 68° F, infection can take place. Temperatures above 86° F and below 40° F inhibit the fungus. If surface moisture is not present then infection does not take place. After the disease is visible, control is impossible. Copper fungicide sprays applied at the beginning of dormancy have proven very satisfactory. Chlorothalonil can also be used at leaf shed and just prior to bud break.

Bacterial Spot of Peach and Plum (bacterium - *Xanthomonas pruni*): Symptoms are observed first as small, circular, or irregularly shaped lesions, pale green in color. During early development, lesions almost always are visible at the tip of the leaf. surface. In advanced stages, angular lesions are formed and surrounded by a halo of lighter colored tissue. The inner portion of the lesion turns black and falls out after a time, giving the leaf a "ragged" or "shot hole" appearance. Leaves heavily infected with bacterial spot turn yellow and eventually fall. The disease first appears as a small, olive brown, circular spot on the fruit surface. Spots become slightly darker and depressed as the bacteria develops. Lesions are scattered over the fruit surface. The most conspicuous phase in advanced stages of fruit infection is "pitting." "Pitting" results when bacteria kill cells in the lesion. As surrounding healthy tissue grows, a "pit" is formed. This "pit" serves as an entry for other diseases such as brown rot. A "gum flow" often results from the lesion and further disfigures the fruit. The area below the "pit" is corky and unpalatable.

Fruit infected with the bacterial spot organism is unsuitable for sale except as culls. Twigs are damaged by two distinct types of lesions. "Spring cankers," develop in young succulent twigs of the previous summer's growth. They appear as water-soaked, slightly darkened blisters about the same time as first leaves appear. As the season progresses, the epidermis over the lesion ruptures and releases bacteria. The lesion then dries and becomes inactive. "Summer cankers" are restricted in size with indefinite margins. Bacteria overwinter in late infected twigs. The "fall cankers" are invisible as are these "summer cankers." "Spring cankers" are related to the amount of foliage infection which occurred the previous year.

Bacteria develop in leaves and serve as inoculum for later fruit, leaf and stem infections. leaves, and stems. Repeated infection occurs throughout the growing season as long as the environment is favorable for disease development. In the fall, bacteria enters twigs and undergo limited development. If trees are still actively growing, the bacteria will be walled off. Chemical control during the season is difficult. Dormant sprays have been somewhat effective, if the spray is timed to protect stems during the fall infection period. Copper containing fungicides should be applied just as the leaves begin to shed.

Peach Scab (fungus - Cladosporium carpophilum): Peach scab is a fungus which reduces attractiveness of fruit and can cause leaf spotting. The fungus is found wherever peaches are grown. It is most apparent on late season varieties. Peach scab is often called "freckles" or "black spot." On peach the disease is distinguished by irregularly defined, olive-colored spots. Lesions normally occur around the stem. Host cells are killed, and since they are unable to expand, small cracks are formed. Lesions formed on young twigs serve as a means of overwintering by the fungus. Primary infection in the spring comes from spores produced in twig cankers formed the previous year. They are spread by wind and rain. Fruit infection normally occurs at petal fall, shuck split and first cover. Once infection occurs, 40 to 70 days may elapse before the disease is visible. Control is by repeated applications of an approved fungicide during the critical period around shuck split.

Coryneum Blight of Stone-Fruit (fungus - Coryneum beijerinckii): Blight lesions on fruit and leaves are small, circular, purple spots which in advanced stages spots on the leaves fall out giving the leaf a ragged appearance. Defoliation seldom occurs unless infection is severe. Twig cankers produce inoculum the next spring. Severely infected twigs die. On fruit infection is a superficial purple spot. Rarely is it severe enough on the fruit to be an economic problem. For most effective disease control, apply dormant sprays immediately after leaves are shed or just prior to budbreak in spring.

Brown Rot (fungus - Monilinia fructicola): This fungus attacks fruit in blossom stage at maturity, and during storage. Surface moisture and moderately warm temperatures favor fungus development. Blossom blight is the stage where blossoms become brown and water-soaked. The fungus grows down the pedicel into the stem resulting in dark brown, sunken areas. These areas often completely girdle the stem and cause twig dieback. In some instances, young fruit may become infected but not show symptoms of the infection until the fruit matures. During periods of high humidity, diseased blossoms and infected peduncles from the previous crop become covered with "tufts" of gray spores. These spores serve as inoculum for later infections as the fruit matures. The fungus enters through natural openings or wounds and rapidly develops a brown, water-soaked lesion on the fruit. Healthy fruit touching diseased fruit quickly decays. The brown rot fungus overwinters in mummies, stem cankers and on infected fruit peduncles. Dried fruit beetles can as vectors for the fungus. Control is by applying fungicide during pink bud, bloom, petal fall, and at preharvest. Increased fungicide applications at preharvest and during harvest may be required during periods of rain. Orchard sanitation is also an important part of brown rot control.

Rhizopus Rot (fungus - Rhizopus stolonifer): This fungus is most active during warm, humid weather. Fruit infection results in a "black whiskered" appearance caused by fungal strands which produce an abundance of black spores. Rhizopus rot only attacks peaches and plums at maturity. Disease prevention is based on orchard sanitation, use of fungicides, and refrigeration. Remove decayed fruit from the orchard or disk it under the soil surface. Picking containers should be such that fruit receives a minimum amount of handling. Picking boxes are inexpensive and can reduce fruit losses. They should be treated regularly with Captan to prevent fungal spread. Dip or use a high pressure fungicide spray to wet containers. Treat containers daily during periods of high brown rot incidence. Allow them to dry before using. Packing equipment should cause minimum damage. Pad any area where fruit will drop onto a belt or roller. Clean grading and packing equipment periodically to eliminate possibility of contamination. Use a solution of one part household bleach and nine parts water to wash conveyor belts, rollers, and packing tables. Make sure all equipment is dry before using. After grading, place fruit in packing containers which have not been used previously to store fruit. Container walls should be strong enough to be stacked in storage. Material used in fabricating containers should retain its strength after continued exposure to high humidity in cold storage. Use a well-planned spray schedule to prevent normal loss. Fruit that is to be stored must be refrigerated.

Rust (fungus - Tranzschelia discolor): Rust occurs on both peach and plum trees. Reddish-brown pustules occur on the lower leaf surface marked by a yellow spot on the upper surface. It causes leaves premature defoliation which reduces tree vigor. When rust appears, apply wettable sulfur on a 14-day schedule. This will not totally control the fungus but will reduce disease incidence of disease.

Phony Peach (virus): This virus disease of peaches does not cause rapid death of the tree but results in reduced growth and fruit size. Twigs on diseased trees have shortened internodes and increased lateral branching. The general appearance is a dwarfed, compact growth pattern with dark green foliage. After a few years, the wood becomes brittle and terminal dieback is common. Infected trees leaf out first in the spring and hold their foliage later in the fall. Fruit also ripens earlier on diseased trees. Disease is spread by root grafting and leafhoppers. Remove all trees showing symptoms of phony peach and destroy wild plums growing near the orchard.

Peach Yellows (mycoplasma): The disease has been observed in Texas and is caused by a mycoplasma. Fruits on diseased trees ripen from a few days to three weeks prematurely, have a bitter taste, and are reduced in size. Varieties which normally have red skin are abnormally bright. Leaves are chlorotic, fold upward, and tend to droop. Infected trees leaf out prematurely. The disease is spread by grafting and feeding by the plum leafhopper Macropsis trimoculata (Fitch). After infection, it may be 40 days to three years before disease symptoms are visible. Use only bud wood from healthy trees and destroy any trees which show typical disease symptoms.

Peach Mosaic (virus): This is a virus disease which affects peach and plum trees. General symptoms are delayed foliation with small, narrow, crinkled, mottled, yellow leaves. Internodes are shortened, and lateral buds break give a rosette appearance. Fruit is deformed resulting in bumpy, misshapen fruit. Spread is by grafting and insects. Plant trees from reputable nurserymen. Remove all virus-infected trees as soon as they are discovered.

Pythium Root Rot (fungi - Pythium spp.): Affected trees have reduced feeder root development which results in a slow decline of trees. P. irregulare is favored in cool soils (55° F.), and P. vexans is active in warm soils. Pythium spp. feeds on the small feeder roots and makes the trees more susceptible to stress conditions such as heavy fruit set and drought. Roots develop necrotic lesions when infected with either of the two species of fungi. Avoid replanting in old peach soils. Chemical control has not proven effective against this complex of organisms.

Phytophthora Root Rot (fungus - Phytophthora cinnamomi): Roots infected by this fungus show extensive root necrosis. This necrosis will be present on the large roots and trunk while Pythium Root Rot is restricted to smaller feeder roots. Although Phytophthoral Root Rot has not been verified in Texas, its presence is suspected based on its wide distribution. Phytophthora Root Rot is most severe on replant soils or in areas where the orchard is planted poorly drained soils.

Cytospora Canker (fungus - Cytospora leucostoma): The fungus which causes Cytospora Canker is a weak pathogen and is rarely a problem in well cared for orchards. The first symptom is the formation of a small pimple-like canker on a limb. During the growing season small streams of gum are formed at each pimple. In most cases a callus layer forms around the damaged area and the canker is walled off. In a few cases the canker growth will resume in the fall after the callus growth is slowed. Cytospora Canker may become established in a limb following a mechanical damage which injures the bark or it may invade pruning cuts. Maximum spore release is in June, but infection can occur at any time due to the continual presence of spores in the trees. Affected trees should be pruned to remove the canker sites and fertilized with above normal levels of fertilizer.

Waterlogging (physiological): Peach trees growing in soils which do not drain well are characterized by rapid yellowing and wilting of the foliage. Although waterlogging can occur at most any time during the growing season, results are the most serious during the warmer months of the year. In controlled tests, five days elapse from the time the trees are waterlogged until wilting occurs at 80° F, and 12 days elapse from the time the trees are waterlogged until wilting occurs at 62° F. Plum rootstocks are much more tolerant of the waterlogging problem. It requires 10 days at 80° F and 45 days at 62° F before plums show the effects of waterlogging. Waterlogging is associated with poor interval drainage within a field. A yellow to gray clay subsoil can indicate poor drainage. Prior to planting, core samples should be taken to determine the subsoil condition within a field. It is best to take the core samples when the soil is wet. If free moisture is present in the sample hole 24 hours after digging, this would indicate a problem with drainage. If any gullies or ditches exist within a field, they can yield valuable information as to the condition of the subsoil. Although waterlogging is most often associated with land which has little or no slope, it can also be a problem on a field which has a major slope if the subsoil restricts water movement.

Poria Root Rot (fungus - *Poria* spp.): Poria Root Rot is caused by a soil-borne fungus which forms a thick, white to slightly off-white mycelium growth at the base of the tree trunk. This growth can may extend out from the base for 6 to 12 inches and from one-half to one inch thick. Trees infected with Poria root rot show a slow decline. A more rapid tree death occurs when the tree is infected by a second pathogen such as *Pseudomonas syringae* (Bacterial Canker). No control is recommended at this time.

Crown Gall: (See section on Crown Gall.)

Mushroom Root Rot: (See section on Mushroom Root Rot.)

Cotton Root Rot: (See section on Cotton Root Rot.)

Root Knot: (Nematode - *Meloidogyne* spp.)

PEACH

Peach Rootstock and Their Reaction To Root Knot

Rootstock	Root Knot (*Meloidogyne* sp.)
Okinawa	Resistant
Nemaguard	Resistant
S-37	Resistant
Lovell	Susceptible
Elberta	Susceptible
Nemared	Resistant (Has not been extensively evaluated in Texas)

Different races do exist between species, and they have been shown under greenhouse conditions to attack "resistant rootstock."

PEAR

Pyrus communis

Fire Blight (bacterium - Erwinia amylovora): The bacterium causing fire blight overwinters at the margins of the cankers formed on twigs and branches in the previous season. Active bacteria are in the healthy tissue next to the canker rather than in the canker. In the spring the bacteria begin to multiply at the same time growth starts. As the bacterium increases, an ooze is formed at the margin of the canker. Insects are attracted to the ooze and it is carried to the open blossoms. Splashing rain can also spread the bacterium. Once bacteria enter a blossom, the blossoms are blighted within 7-10 days after infection. Bacteria continues to be spread further by insects visiting the blighted blossom and carrying the bacteria to adjoining blossoms. Spread by honey bees is increased during periods of warm temperature, sunshine, and still air. After blossom infection, bacteria spread into the fruit peduncle and finally into the twig. Ooze is continually being produced which can add to secondary infection. During periods of high humidity, the bacteria can enter into young leaves. Fire blight is favored by a mean temperature of 60° or above. The control of fire blight is based on several steps:

1. Plant resistant or tolerant varieties: Kieffer, Orient, Garber, or Douglas.
2. Maintain balanced fertilizer level. Do not use excess levels of nitrogen.
3. Prune during dormant months. Summer pruning may encourage tender succulent growth which is more susceptible to disease.
4. Remove overwintering bacteria cankers by pruning. Make pruning cuts 8 to 12 inches below visible sign of disease.
5. Apply bactericides on 5 day intervals between early bloom and late blooms.
6. Reapply a bactericidal spray to an orchard if it is damaged by hail or receives a heavy rain immediately after an application.

Leaf Blight and Fruit Spot (fungus - Entomosporium maculatum): Leaf spots first appear as small purple spots which enlarge. As the spots get older, they develop purple margins with brown centers. Fruit spots are one-fourth inch in diameter, black, and slightly depressed. They sometimes coalesce to cover a large portion of the fruit surface. Lesions also occur on twigs and are the overwintering inoculum. In the spring, twig lesions produce spores which are washed by rainfall to leaves. After infection there is a period of one week before symptoms are observed. Secondary infection can occur during the spring and summer when the temperature is near 75° F. and surface moisture is on the leaves. Fungicides should be applied at full leaf development and continued at two week intervals for four sprays.

Bitter Rot (fungus - Glomerella cingulata): The fungus attacks apples and pears and enters the fruit through uninjured skin. Infected fruit are characterized by a firm rot which forms a circular light brown spot. With age the spots become almost black and have a saucer-shaped depression. The organism overwinters in decayed fruit and in cracks on the old bark. A broken limb or twig will serve as an overwintering site. Symptoms are first noticeable in mid to late July. A temperature of 85°F and light rain favor development of the rot. Good sanitation will help reduce losses from this disease. Remove all broken limbs and decayed fruit. Once the disease begins to show up, spray at seven day intervals for two or three applications.

Black Rot (fungus - *Physalospora obtusa*): Black rot is a firm-textured rot. The spot at first is light brown but darkens with age. A circle of raised dark postules are formed in the center of the spot. Infected leaves are covered with many small purple specks. At maturity the spots are purplish cast with brown centers. Twig infections are small, sunken, reddish-brown areas. The organism overwinters in cankers, decayed fruit, and dead wood. In the spring spores are formed in the cankers. Leaves are the first tissue to be infected. A temperature of 80° F. and rainfall encourage disease development. Infection generally takes place at the blossom end of the fruit as it reaches maturity. Sanitation is one of the more important means of control. Remove all dead twigs, limbs, and decayed fruit. Fungicides must be applied when the fruit is beginning to expand in the spring.

Bot Rot (fungus - *Botryosphaeria ribis*): The fungus attacks both woody tissues and fruit. On limbs, new infection shows up as small blisters. These lesions serve as a source of inoculum for next spring. Fruit infection results in small, reddish-brown spots which develop rapidly causing a soft rot. A temperature of 75° F or above favors the development of the fungus. Bot rot is most damaging on weak trees. During periods of rapid twig growth, the diseased area will be sloughed off. Prune out any dead or diseased wood. Fungicides will need to be applied from immediately after bloom until near harvest.

Pear Scab (fungus - *Venturia pyrina*): Symptoms of apple scab and pear scab are similar except pear scab will attack twigs. Twigs are a source of early spring inoculum. The control program for apple scab will also control pear scab.

Stony Pit (virus): This disease is one of the more common viruses found on pears in Texas. The outer flesh of infected fruit is gnarled and deformed. When the fruit is cut, it has brown, hard structures scattered throughout the flesh.

Bitter Rot, Fly speck, Sooty Blotch: (See section on Apple.)

Cotton Root Rot: (See section on Cotton Root Rot.)

Mushroom Root Rot: (See section on Mushroom Root Rot.)

Crown Gall: (See section on Crown Gall.)

PEAR

Pear Varieties and Their Reaction to Fire Blight

Variety	Reaction
Keiffer	R
Orient	R
Garber	MR
Douglas	MR
Bartlett	S

S = Susceptible

MR = Moderately Resistant

R = Resistant

PLUM

Prunus domestica and Prunus salicina

Bacterial Canker (bacterium - Pseudomonas syringae): Cankers develop at the base of infected buds on trunk and scaffold limbs. Cankers spread more rapidly above the point of infection than below and only slightly to the sides. This results in a long, narrow canker. Cankers develop during the fall and winter but are not visible until late winter and early spring. Damaged areas are slightly sunken and somewhat darker in color than surrounding bark. As the trees break dormancy in the spring, gum is formed and flows down the outside of the tree. Cankers have a soured smell. Cankers start development in the fall at the base of a bud. The infected areas increase in size during the cool fall months. If infection takes place early in the fall when the trees are still active, the area is walled off by callous and no further development occurs. The bacterium is a weak pathogen and causes serious damage only when a tree is in a near dormant condition or weakened due to unfavorable growing conditions. The bacterium is spread by wind, rain and infected budwood which can also be a method of spread. Avoid using high fertilizer rates in the late spring or early summer. This allows a tree to enter dormancy normally rather than encouraging late fall growth which is more easily infected. Prune when trees are fully dormant (January and February). Trees pruned early in the year prior to dormancy can be infected with the bacterium carried on pruning shears. Trees showing signs of bacterial canker should be left and pruned after all other trees have been completed. Early pruning encourages late fall growth of trees which is more susceptible to the bacterium. When pruning diseased trees, dip pruning equipment in a solution of 1 part household bleach and 9 parts water. At the end of the day, rinse and oil lightly to stop corrosion.

Brown Rot (fungus - Monilinia fructicola): This is a fungal disease of plums which attacks fruit in the blossom stage, as the fruit approaches maturity, and during storage. Surface moisture and moderately warm temperatures encourage its development. Fruit damaged by wind, hail, insects, or mechanical means is more susceptible to this organism. Blossom blight is the stage where blossoms are killed by the fungus. Infected blossoms are brown and water-soaked. The fungus grows down the pedicel into the stem which may cause twig dieback or a canker. During high humidity, diseased blossoms and stems may become covered with "tufts" of gray spore masses. The "tufts" are inoculum for further infection as the fruit matures. On mature fruit, the fungus enters through natural openings or wounds and rapidly develops a brown, water-soaked lesion. The organism overwinters in mummies, stem cankers and old fruit peduncles. Control is by repeated fungicide application and sanitation. Picking containers should be cleaned with a captan solution. Packing containers should be new.

Coryneum Blight of Stone Fruit (fungus - Coryneum beijerinckii): See section on Peach.

Bacterial Spot of Plum (bacterium - Xanthomonas pruni): Symptoms are observed first as small, irregularly shaped lesions. The spots are pale green in contrast to the dark green surrounding tissue. In advanced stages, angular lesions are formed and surrounded by a halo of lighter colored tissue. The inner portion of the lesion turns black and drops out at maturity. This gives the leaf a "ragged" or "shot hole" appearance. Leaves heavily infected with bacterial spot turn yellow and eventually fall. Disease first appears as a small, olive-green, circular spot on the fruit surface. However, as the disease develops, spots become darker and lesions are scattered over the fruit surface. In advanced stages of fruit infection, "pitting" occurs. "Pitting" results when bacteria kill cells in the lesion, and as surrounding healthy tissue grows, a "pit" or split is formed. This "pit" serves as an entry for other disease causing pathogens. During periods of high humidity, gum flows from the lesion which further disfigures the fruit. The area below the "pit" is corky and unpalatable. Fruit infected with bacterial spot is unsuitable for sale. Twigs are damaged by two distinct types of lesions. "Spring cankers" which develop on young, succulent twigs of the previous summer's growth appear as water-soaked, slightly darkened blisters about the same time as first leaves appear. As the season progresses, the epidermis over the lesion ruptures and releases bacteria. In time the lesion heals and becomes inactive. "Summer cankers" are restricted in size with indefinite margins. Bacteria overwinter in summer canker infected twigs. The summer cankers are the overwintering site for the bacteria. Bacteria also reproduce in lesions on the leaves and this serves as inoculum for later infection. Repeated infection occurs throughout the growing season as long as the environment is favorable for disease development. In the fall, bacteria are carried to young, succulent stems where infection is through natural openings. If the trees have stopped active growth, bacteria enter the host and undergo limited development. However, if the trees are still actively growing, the host plant responds by walling off bacteria. This results in the bacteria dying. Chemical control during the season is ineffective. Dormant sprays have been somewhat effective, the spray is accurately timed to protect the stem tissue during the fall infection period.

Rust (fungus - Tranzschelia discolor): Rust occurs on both peach and plum trees. Reddish pustules occur on the lower leaf surface marked by a yellow spot on the upper surface. It causes premature defoliation. After the crop has been harvested, make applications of a protective fungicide on a 2-3 week interval until October 1.

Cherry Leaf Spot (fungus - Coccomyces hiemalis): Infected leaves have small circular purple lesions which turn brown and eventually drop out. This gives the foliage a ragged or shot hole appearance. The fungus overwinters on old leaves. The disease is most active at 60° to 68° F. Rainfall is necessary for disease development. Protective fungicides must be applied throughout the growing season to get effective control.

Black Knot on Plum (fungus - Apiosporina morbosum): Affected limbs and twigs are malformed as a result of black woody growths (galls). The galls are similar to those caused by crown gall on the root system. The disease is more prevalent on the small twigs, but under severe disease conditions it may be found on large limbs. Infection of new wood occurs from bloom until shuck split stage. Primary inoculum comes from one to two year old galls. The fungus can penetrate the uninjured epidermal stem tissue. As the fungus grows, it may develop further down the twig and form a secondary gall. Control of black knot is by sanitation. Prune and destroy the galled tissue. Make cuts two or three inches below the gall to insure complete removal of the fungus. Fungicides applied in the early bloom periods will help reduce the occurrence of this disease.

Plum Pockets (fungus - Taphrina pruni): Fruit infected with the plum pockets fungus are puffy and distorted and they fall soon after infection. The first symptom of infection is presence of small whitish spots on the plum. This happens two to three weeks after shuck split. Once infected, the flesh becomes spongy and the embroyo is killed. The skin of the fruit is first a reddish color and then a velvety gray. For this disease to develop, cool, wet conditions are necessary during early fruit development. It is similar to peach leaf curl in its dependence on weather for infection. The fungicide program used to control peach leaf curl will also control plum pockets.

Peach Stem Pitting (virus): See peach.

Peach Mosaic (virus): See peach.

STRAWBERRY

Fragaria chiloensis and Fragaria ananassa

Leaf Spot (fungus - *Cercospora fragariae*): This is one of the more common leaf spots of strawberry. It occurs in all areas of Texas. At first, small round purple spots are seen on the upper side of the leaves. As the leaf matures, the center of the spot becomes tan or gray then almost white while the edges of the spot remain purple. On the underside of the leaf, the spots are bluish or tan in color. The fungus causing leaf spot overwinters easily in Texas since strawberries are a perennial plant in Texas, and there are always present enough infected leaves to provide inoculum. Varieties vary in their resistance to leaf spots. Chemical control can be obtained using a well planned spray program with repeated application. Sprays must be applied with enough pressure to obtain thorough coverage on the upper and lower side of the leaves.

Leaf Scorch (fungus - *Marssonina fragariae*): The disease is similar to leaf spot. At first, small dark purple spots up to one-fourth of an inch in diameter appear on the upper side of the leaves. These spots never have light centers as do those of leaf spot and they have a more irregular outline. At maturity, the leaf spots are large and irregular in outline and never show the white center described for leaf spot. The disease can also attack other parts of the plant, and the spots may appear on other affected parts. Sanitary measures such as raking and burning of old leaves, clean cultivation, and frequent renewal of the plants may help reduce disease losses. Some varieties have resistance to leaf scorch. Fungicide applications at repeated intervals should give adequate control. Follow recommendations as for leaf spot control.

Red Stele (fungus - *Phytophthora fragariae*): This is the most serious root disease of strawberries. It occurs during the late winter and spring. This fungus attacks only strawberries. The fungus is spread from one area to another primarily through diseased plants. In a healthy plant, the roots are a yellowish-white and in a diseased plant, the center is a distinctive brownish-red. Infected plants are stunted and wilt in dry weather. The root systems have a rattail appearance with few lateral roots produced. The disease is more disastrous in low, poorly drained fields during cool weather. There is no chemical or cultural methods for reducing disease losses, except to replant resistant varieties. The fungus does not persist in well drained soils. To prevent the possible build-up of a more virulent strain of the fungus, crop rotation should be practiced. Transplants should be thoroughly examined for the rattail appearance to prevent bringing in diseased plants. Avoid planting any but resistant varieties which are adapted to your area of Texas if the disease is known to occur in your garden or field.

Verticillium Wilt (fungus - *Verticillium albo-atrum*): This is a widespread soil-borne disease of strawberries occurring in cool, poorly drained soils. Symptoms show up as a burning of the outer margins of the leaves. Young roots turn black at the tips and die back. If Verticillium has been a problem in your area, consider a variety which has resistance to the wilt organism. Soil fumigation with a chloropicrin-containing fumigant is recommended when resistant varieties are not available. When using soil fumigants, follow manufacturer's directions and use caution in handling the material.

Black Root Rot (various fungi): The exact cause of black root rot is unknown. It has been associated with several different organisms or conditions. The symptoms of black root rot are a black and woody root system. On healthy plants, the roots will appear white and pliable; however, diseased plants will have a stiff root system. The feeder roots are partially or completely destroyed. The tip of the main roots will be destroyed. Fumigation has helped with this problem.

Anthracnose (fungus - Colletotrichum fragariae): The fungus attacks leaves, stolons, petioles, fruit and plant crown. Leaf infection is known as black leaf spot. Elongated brown to black lesions appear on stolons and petioles when infected. The most serious phase is crown infection which results in poor runner production and plant death. A longitudinal cut through the crown reveals a firm, reddish brown rot. Avoid excess fertility which favors disease development. Anthracnose is difficult to control with fungicides. When observed use fungicides as often as label allows.

Fruit Rots (fungi - Botrytis cinerea, Rhizoctonia spp.): fruit rots destroy a large percentage of the fruit each year in Texas. There are several organisms involved in this complex. Symptoms will be somewhat different for each disease. Gray mold rot Botrytis) is the most damaging. It attacks the green fruit as well as the ripe fruit. The first sign of infection is where the fruit has touched the ground or another diseased strawberry. It begins as a small, brown, soft spot. the spot spreads rapidly, often giving the berry a whiskered effect. To control this disease, the plants must be spaced so that the foliage or fruit does not stay wet for extended periods of time. The hard rot, caused by Rhizoctonia, attacks only ripe fruit that are in contact with the soil while growing. Affected berries are usually one sided and show a hard brown area on the side that touched the ground. Other control measures that will help reduce diseases should be used. Avoid applying heavy applications of fertilizer in the spring. Spring fertilization will cause the foliage to be dense and thus reduce the rate at which the soil dries. Spraying or dusting with fungicides will prevent harvest rots if properly applied. Spray with a fungicide as soon as the young fruit bud becomes visible and continue spraying every two weeks until the fruit is one-third grown. Additional sprays may be required if the weather is cool and wet.

Consult the Chemical Control Supplement (B-1140A) for specific chemical control suggestions.

STRAWBERRY

Variety	Leaf Spot	Leaf Scorch	Red Stele	Verticillium Wilt	Anthracnose	Virus Diseases
Cardinal	R	R	S	S	-	-
Sunrise	S	R	R	R	S	-
Sequoia	R	T	S	S-I	R	T
Tioga	S	-	S	S	S	T
Douglas	-	-	S	S	S	-
Tangi	R	R	S	S	S	-
Fort Laramie	I	I	S	I-R	S	-
Ogalla	R	-	S	-	S	-
Ozark Beauty	R	R	S	S	S	-
Pocahontas	R	I	S	S	I	-
Sure Crop	R	R	R	R	S	T

R = Resistant
S = Susceptible
T = Tolerant
I = Intermediate

BLACK WALNUT

Juglans nigra

and ENGLISH WALNUT

J. regia

Walnut Blight (bacterium - *Xanthomonas campestris* pv. *Juglandis*): Infection appears first on the leaves as reddish-brown spots. Stem infections are black, slightly sunken spots which in severe cases will girdle the stem. The bacterium also attacks the young leaf and catkin buds causing defoliation. Infected nuts have black, shining spots of varying sizes. The bacterium can penetrate the husk, shell and in some instances the meat. The bacterium overwinters in old shucks, buds and cankers on the previous years growth. It is spread by rain to the new growth. Frequent and prolonged rains just before and during the blooming period and for about two weeks after bloom can result in serious disease losses. It is during this time that the nuts are the most susceptible to disease. Infection that occurs after the nuts are three-fourths grown is of little economic importance since the bacteria seldom penetrate the shell.

Sprays should be applied at early prebloom, late prebloom and early postbloom. A fourth spray may be required two weeks after the early postbloom if rainy conditions continue.

The early prebloom spray would be the same as a bud break spray in pecans. Late prebloom would be just as the young nutlet is exposed, and the postbloom spray is immediately after pollination. Coverage of the young nutlet and foliage is critical to effective control. A spray missed or delayed for a few days can result in significant loss in quality and quantity.

Walnut Anthracnose (fungus - *Gnomonia leptostyla*): Anthracnose is most damaging during wet weather and it can cause complete defoliation by late July or August. Premature defoliation restricts a trees growth. Infected leaves are covered with tiny circular dark-brown or black spots. The spots continue to develop and eventually grow together to form large dead areas in the leaves. The spots are bordered by yellow leaf tissue. Walnuts from these trees are generally dark, unattractive and shriveled. Sunken, necrotic spots are formed on the shucks. Early infection can cause nut drop. Stem lesions are necrotic sunken areas which are oval to irregularly circular in shape, light grayish brown in color, and have dark reddish brown margins.

The fungus overwinters in old infected leaves. In the spring they are discharged upward where they are moved by wind currents to developing leaf tissue. It takes 14 to 16 days for lesions to become visible. Secondary infection can occur if weather continues to favor disease development. The rapid increase and spread of walnut anthracnose in the summer and fall is by repeated secondary infection.

Destruction of all leaves from around the walnut trees will help reduce losses from this fungus. Fungicides are applied at the one-half leaf development and then repeated at two week intervals for two additional sprays.

Crown Gall (bacteria - Agrobacterium tumefaciens): Infected trees are weakened and are more subject to infection after stress conditions resulting from weather and other diseases. Roots which are infected have large galls ranging from one to several inches in diameter. For more information see section on Crown Gall.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Infected trees die rapidly after infection. Plants die in a circular pattern in the grove, as the infection spreads from tree to tree. No control currently recommended. For more information see section on Cotton Root Rot.

HICKORY

Carya aquatica, C. cordiformis, C. glabra, C. ovata, and C. tomentosa

Liver Spot (fungus - Gnomonia caryae): This is the most serious foliage disease of hickory. It causes large reddish brown circular spots on the upper leaf surface. The fungus overwinters in old leaves and releases spores in the spring which are carried up to the immature leaves.

Vein Spot (fungus - Gnomonia nerviseda): This fungus attacks the petiole and veins of hickory leaves and results in premature defoliation. Lesions on the leaves are reddish brown in color. The imperfect stage of the fungus (Leptothyrium nervisedum) attacks the young foliage. Gnomonia nerviseda (the perfect stage) is present in fallen leaves as the overwintering stage.

Leaf Spot (fungus - Cercospora caryae): Infected leaves have numerous small, dark brown spots that may cause the entire leaf to turn brown and drop. Other Cercospora species also causes a leaf blotch on hickory. Orchard sanitation and well managed trees will be less likely to be damaged by either of the fungi.

Powdery Mildew (fungus - Microsphaera alni): Leaf infection results in distortion similar to that caused on seedling pecans. A faint white powdery growth is formed over the leaf surface. This is most prevalent in nurseries where there is poor air circulation.

Wide spacing of trees at planting, pruning to improve air circulation and use of a fungicide will eliminate this problem.

Violet Root Rot (fungus - Rhizoctonia crocorum): Infected roots turn reddish or violet in color and eventually kill the root. Has not been observed in Texas.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Has been reported on hickory but has not been observed causing serious losses. Infected trees die rapidly after infection. The fungus is soil-borne and is associated with high pH soils. No control currently effective. For more information on cotton root rot refer to Cotton Root Rot section.

Crown Gall (bacterium - Agrobacterium tumefaciens): Infected roots have large rough galls which may be several inches in diameter. Trees infected with this bacteria are weakened and are more subject to drouth stress and stresses resulting from other disease causing organisms. For more information on Crown Gall refer to section on Crown Gall.

PECAN

Carya illinoensis

Scab (fungus - Cladosporium effusum): The fungus invades young rapidly growing shoots, leaves and later developing nuts. Severely infected nuts fall or fail to develop, which results in a total crop loss. Defoliation occurs during periods frequent rains and mild temperatures. These conditions are optimum for rapid development and spread of the scab fungus. Infection takes place when leaves or nuts are covered with free moisture. The scab fungus overwinters in infected shoots, old shucks, and leaf petioles. In the spring when temperature and moisture conditions become favorable, the fungus begins to develop in lesions and within a few days produces spores. The spores are spread by wind and rain to newly developed leaves where they germinate and initiate new infections.

The fungus produces spores on the surface of the primary infection sites and they are then spread throughout the tree, infecting shoots, leaves and nuts. On the leaves, lesions are formed on the lower leaf surfaces and are characteristically olive brown in color, somewhat elongated in shape and vary in size from a barely discernible dot to lesions one-fourth inch or more in diameter. Frequently, adjacent lesions coalesce, forming large, chocolate brown irregularly shaped spots. Scab lesions occur on or along the leaflet veins, but can be found between the veins. On nuts, scab lesions appear as small black dots which become sunken as they mature. Adjacent lesions on the nuts may coalesce, forming large sunken black lesions. When infection is severe, the entire nut surface is black, development is arrested and the nut drops prematurely or fails to grow in the area of infection.

Pecan varieties vary in their susceptibility to the scab fungus. Among the highly susceptible varieties are Wichita, Cherokee, Western, Chickasaw, and most western varieties. Chocktaw, Kiowa, Cheyenne, Shawnee and Desirable varieties have varying degrees of resistance to the scab fungus. Scab development is favored by rainy periods and cloudy days when the humidity remains high and leaf surfaces are wet. Under these conditions, spores come in contact with the wet leaf surface or nut and germinate rapidly. Infection can occur within six hours. Visible lesions develop in 7 to 14 days, depending on environmental conditions. A period of warm, dry weather after infection may retard lesion development slightly. Control of pecan scab depends primarily on use of a protective fungicide. A protective film of fungicide prevents infection by killing spores after they germinate. Unfortunately, once the fungus has entered the host tissue, it is protected from chemical attack by protective fungicides.

Thorough coverage of leaf, nut and shoot surfaces with a fungicide must be maintained to prevent infections. Sanitation measures, such as removal of old shucks and leaf petioles from around trees and plowing under fallen leaves and shucks, helps reduce infections. Pruning to open up the tree for better air circulation will help reduce scab occurrence. Avoid the use of close spacing in areas where extended periods of rainfall are common during the growing season.

Use highly productive resistant varieties when available.

Brown Leaf Spot (fungus - *Cercospora fusca*): Brown leaf spot affects only mature leaves and usually does not appear until the latter part of May or mid-June. Primary lesions develop on the lower leaf surfaces as small dots which gradually enlarge and become reddish-brown with a grayish cast. The shape of the lesions may be circular or irregular, especially where two or more lesions develop adjacent to each another. In seasons favorable for brown leaf spot development, pecan trees may be completely defoliated within three to four months if the disease is not controlled. Pecan trees which are maintained in vigorous state of growth are less likely to have brown spot. Fungicides will provide some protection.

Vein Spot (fungus -*Gnomonia nerviseda*): The symptoms of the disease are similar to the leaf lesion symptoms of scab disease, but vein spot disease, unlike scab disease, affects only the leaves. Lesions of vein spot disease develop on veins of leaflets and are characteristically dark brown to black. Severely infected leaflets defoliate. The fungus lives in fallen leaves during the winter. Fungicides and sanitation procedures will control this fungus. Fungicides applied for scab will also control vein spot.

Leaf Blotch (fungus - *Mycosphaerella dendroides*): This disease occurs mainly in trees of low vigor. The fungus overwinters in infected leaves on the orchard floor. Symptoms first appear on the under surface of mature leaves in early summer as small olive-green velvety spots. By midsummer, black pimple-like dots are visible in the spots. When the disease is severe, infected leaflets are killed, causing defoliation of the trees in late summer or early fall. This results in reduced vigor. Leaf blotch disease can be controlled in the early spring by disking or raking to remove infected leaves. In areas where multiple fungicide applications are applied for the control of scab, leaf blotch seldom is a problem. In orchards where leaf blotch is a problem, two applications of fungicide will control the fungus. The first spray should be applied after pollination when the tips of the nutlets have turned brown, and the second spray application should be made three to four weeks later.

Crown Gall: (See section on Crown Gall.)

Downy Spot (fungus - *Mycosphaerella caryigena*): Only leaves are susceptible to the fungus. Primary infection occurs on developing leaves in the spring from spores produced in old leaves. Symptoms usually appear during the summer months on the lower surfaces of leaflets. Fungal spores are spread by wind and rain to nearby leaves and neighboring trees. Lesions are one-eighth to one-fourth inch in diameter and greenish-yellow. Later in the season, the lesions turn brown due to the death of the leaf cells in the disease area. Although all pecan varieties are moderately to slightly susceptible, Moneymaker and Stuart varieties are the most susceptible to downy spot disease. Disk or rake under fallen leaves in the fall or early spring before the leafbuds begin to swell. By removing the leaves, spore discharge is stopped. Bud break to casebearer sprays are the most critical in the control of downy spot.

Powdery Mildew (fungus -*Microsphaera alni*): Infected nuts are covered with a white powdery substance. The fungus most often develops in mid-July to mid-August. During periods of frequent rainfall, the fungus seldom is a problem. Rainfall washes the fungus off of the nuts. Pecans which have been infected by the powdery mildew fungus are brown in color. The fungus is sometimes associated with nursery trees or sucker growth around the base of mature trees.

Fungicides applied in the course of the regular scab spray program will control powdery mildew.

Fungal Leaf Scorch (fungus - several): Infected leaves turn brown along the leaf margin or tip. As the lesion matures it becomes gray. Infection can result in defoliation from mid-summer to mid-September. The early infection sites are often restricted to one or two limbs but quickly spreads. The fungus is controlled with fungicides. Mid-summer applications appear to be most effective in the control of this group of fungi causing this disease. The varieties Western, Cheyenne, Chickasaw, Shoshoni, Stuart, and Cape Fear are some of the more susceptible varieties to this group of fungi.

Bunch Disease (mycoplasma): Although the cause of bunch disease is not completely understood, evidence indicates it is a mycoplasma (MLO). Trees affected with bunch disease show the typical bunching symptom, caused by excessive growth of slender succulent twigs from lateral buds that normally remain dormant on the main limbs. In moderately affected trees, one of the several branches will show the "bunch" growth symptoms. Bunching in severely affected trees may involve all main branches which produce thick masses of sucker-like growths and few, if any, nuts. The nuts which are produced are reduced in size. There is no known effective control for bunch disease. Early detection of the first symptom of bunch and pruning out of the affected branches may prevent spread of the disease throughout the tree. When the tree is severely affected and limbs are involved, the tree should be destroyed to protect nearby healthy trees from infection.

Lichens: (See section on Lichens.)

Articularia Leaf Mold (fungus - *Articularia quercina*): The disease occurs most commonly following rainy periods and in areas of high relative humidity on the leaves of poor vigor trees. The fungus produces, on the lower surfaces of the leaves, a conspicuous growth of white tufts which contain masses of spores. Articularia leaf mold does not occur in trees or in orchards which have been sprayed regularly for disease control. A single application of fungicide when the disease is first detected is usually sufficient to control articularia leaf mold disease.

Pink Mold (fungus - *Trichothecium roseum*): Pink mold usually occurs on nuts infected with scab fungus. The pink mold fungus apparently enters the nuts through scab lesions on the shucks and continues to produce masses of pink spores on shuck surfaces until late fall. The fungus sometimes invades the kernel causing "pink mold" which is characterized by an oily appearance of the nut shell and a rancid odor. In areas where scab disease control is regularly practiced, pink mold is not a problem.

Spanish and Ball Moss: (See section on Spanish and Ball Moss.)

Cotton Root Rot (fungus - *Phymatotrichum omnivorum*): Cotton root rot is caused by a soil-inhabiting fungus pathogen that attacks a wide range of host plants including pecan. Roots of pecan tree are invaded during the summer when fungus growth is most active. Infected roots are killed, disrupting the transportation of water to the leaves. Diseased trees usually die one to two years after becoming infected. Losses have been observed several years after planting. An effective control for cotton root rot has not been developed. Orchards should not be planted in soil having a history of cotton root rot disease.

Shuck Die Back (physiological - Possible hormone imbalance): This condition is commonly associated with Success and Success hybrids. Nuts affected by this disorder drop from one to two weeks early. They do not fill properly due to the peduncle being girdled and restricts movement of nutrients into the pecan. This results in what is known as "pops." The shuck turns black and opens at the tip in a normal manner. No control is recommended.

Stem End Blight (fungus - *Botryosphaeria ribis*): This disorder is associated with a fungus which attacks the nuts in the latter part of July and August. Shucks turn black rapidly and drop soon after. Lesions are black, sunken, and shiny. When infected nuts are cut open, the liquid in the kernel has turned brown. This can be controlled with foliar sprays of a fungicide applied when the pecans begin to fill.

Root Knot on Pecans (nematodes - *Meloidogyne* sp.) Small swellings are found on the rootlets. Infected trees develop severe zinc deficiency symptoms. Growers should examine all nursery trees before planting. Chemical control is not recommended. (Refer to Root Knot Nematodes section for further information.)

Kernel Discoloration (fungus - *Nematospora* spp.): Most kernel discoloration is characterized by distinct dark spot on the kernel. This condition most frequently develops after the kernel is damaged by stink bug attack which is followed by fungal invasion. Improper drying of the pecan can also result in kernel decay.

Fungal Twig Die Back (fungus - *Botryodiplodia*): Infected twigs are covered with small raised pustules with black centers. This results in twig dieback. Maintain trees in a healthy condition. No control suggested at this time.

Consult the Chemical Control Supplement (B-1140A) for specific chemical control suggestions.

ORNAMENTAL DISEASES

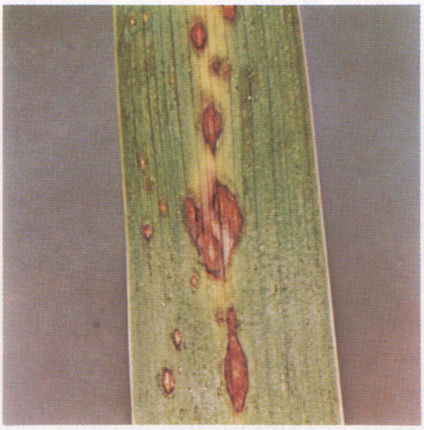
An Aid to Identification and Control

1. DAMPING-OFF OF SEEDLINGS

2. AZALEA LEAF GALL

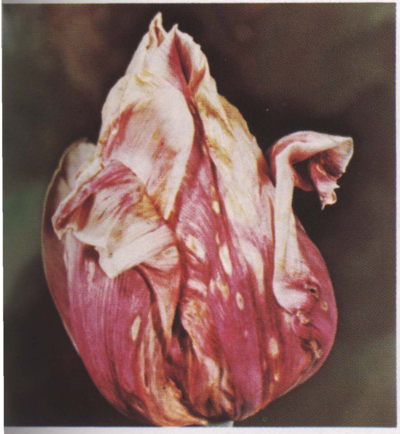
3. CAMELLIA FLOWER BLIGHT

4. BLACK SPOT OF ROSE



5. IRIS LEAF SPOT

6. POWDERY MILDEW OF PHOTINIA



7. FIRE BLIGHT OF TULIP

8. LEAF SPOT OF CHRYSANTHEMUM

9. DIEBACK OF CAMELLIA

PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

[Blank Page in Original Bulletin]

AFRICAN VIOLET (SAINTPAULIA)

Saintpaulia ionantha

Crown Rot (fungi - *Pythium* spp., *Phytophthora* spp., *Fusarium* spp.): Crown rot is probably the most serious disease of African violets and may cause loss of entire groups of plants. Older leaves droop and younger leaves showing stunting. Roots are killed rapidly and appear brown. Unless treatment is administered before massive root death, the plant will have to grow an entirely new root system before recovery occurs. Two alternatives are available for infected plants: One is to discard all affected and exposed plants and the other is to use fungicide drenches. Drenches should be administered when the first evidence of disease occurs. Caution should be used in getting the right dosage levels since excessive levels of some chemicals may damage plants. Preventive measures include using sterilized soil and avoiding plant introductions that may harbor crown rot organisms.
Botrytis Blight (fungus - *Botrytis cinerea*): Leaves, flowers and petioles develop small water-soaked spots that enlarge rapidly. A grayish fungal growth may be seen upon close examination of diseased tissue. The disease is more severe when atmospheric conditions are cool and damp, poor air circulation exists and when light intensity is low. All disease tissue should be removed as this serves as a source for new spores. Surface sterilize the area surrounding the plants with a household cleaner or bleach.

Powdery Mildew (fungus - *Oidium* spp.): A white powdery type substance may be observed on leaves, petioles, petals or flower stems. It is more easily seen on dark blossoms than white ones even though the white varieties may be slightly more susceptible. Spores of the fungus are air-borne from one plant to another. Control with fungicides is very effective. If the systemic fungicide is used, one may have to spray blossoms since the fungicide is not translocated to floral parts when the pot drench method is employed.

Petiole Rot (Physiogenic): An orange to brown, rust colored spot appears where the petiole touches the pot. The petiole and leaf may collapse. This damage results from salt accumulation on the rim of the pot and the soil surface. Use rain water or another salt-free source of water and avoid over fertilization. Construct a collar from aluminum foil to be fitted around the rim of the pot.

Ring Spot (Physiogenic): Light brown rings form on leaves with some running together to form irregularly shaped spots. This condition is caused by cold water coming in contact with the leaves. In some cases, damage may occur even if warm water is used. Such a possibility exists when a breeze blows across the wet area and produces an evaporative effect. Water should be kept off leaves.

Root Knot (nematode - *Meloidogyne* spp.): Galls form on roots of plants causing the root system to be inefficient in absorbing and translocating water and nutrients. This condition can be prevented by using nematode free propagating stock and a sterilized potting medium. The nematode may also be transmitted by petiole cuttings from infected plants. Do not use infected plants for propagation.

Crown Gall (bacterium - Agrobacterium tumefaciens): Fleshy galls form around the base of the plant with a profusion of leaves being produced at that point. Natural infection seems to be slight but infected tissue is perpetuated by some who sell this unusual looking plant under the name of "Witchcraft". Infected plants should be discarded.

Viruses (virus - several): Infected plants have distorted leaves that are mottled in color. Infected plants are not killed but should be discarded because they may serve as a possible source of infection for other plants.

AMARYLLIS

Amaryllis belladonna

Leaf Scorch or Red Blotch (fungus - *Stagonospora curtisii*): Flower stalks are affected resulting in their being distorted and stunted. Affected stalks have bright red lesions that are one-fourth to one-half inches wide and several inches long. Affected flower stalks grow at an angle instead of the normal erect manner. In the later stages of infection, a white to brownish-gray mycelium develops in the center of cankers. The fungus is carried over in bulbs and discolored bulbs should be discarded. Foliar fungicides may be used to protect above-ground parts.

Bulb Rots (fungi - *Botrytis* spp., *Rhizopus* spp., *Sclerotinia* spp., *Pythium* spp. and others): Bulb rots caused by fungi are quite common. The fungi may enter the outer scales and progress inward until all scales are infected. Bulbs showing signs of infection should be discarded to prevent contamination of the beds. Soil sterilization with chemicals or with steam may also be helpful.

Mosaic (virus): Infected plants are stunted and have yellow mottled leaves. The mottle becomes more severe with stunting of all plant parts as time progresses. There is no chemical control and once a plant becomes infected it will remain that way throughout its life. Infected plants should be destroyed.

Southern Blight (fungus - *Sclerotium rolfsii*): A white fungal growth appears at the ground line and infects the plant at that point. Damage results in death of the above-ground portions. Small bead-like structures (sclerotia) appear among the white fungal strands and serve as overwintering bodies for the fungus. A drench with a soil fungicide is usually sufficient to correct the problem. Avoid the accumulation of plant residue around the plant base.

ASTER

Aster spp.

Leaf Spots (fungus - Aschochyta spp., Septoria spp., Cercospora spp., Alternaria spp., Phyllosticta spp.): Leaf spots may form in any stage of growth. Flower parts and stems may also be affected. Older leaves are generally affected first. Foliage may gradually wither and die starting with the lower leaves. Overhead sprinkling or watering will increase severity of disease. Spores of the causal organisms may be seed borne and use of seed treatment fungicides will reduce disease incidence. Planting in wet, poorly drained areas should be avoided. Foliar fungicides should be applied at the first sign of disease and continued at 7-10 day intervals.

Foot Rot (fungus - Phytophthora cryptogea): A rapid, permanent wilting of the leaves and a brownish-black discoloration appears on the lower portion of the stem. The stem may shrivel and collapse at or near the ground line. Roots may be affected by a soft, water-soaked decay. Adventitious roots may form close to diseased portions of the roots. Diseased plants are pulled easily from the soil, but outer bark of the roots sloughs off and remains in the soil. Plant only in well drained soils. This disease is soilborne and once the soil is infested, asters should not be replanted.

Root and Stem Rot (fungus- Rhizoctonia solani): The fungus may attack roots, stems and lower leaves. Symptoms on lower leaves first appear on those leaves in contact with the soil. Affected leaves are characterized by a well defined water-soaked area that progresses rapidly during cool, moist conditions. At first, the leaf is a dark green; it then wilts and turns dark brown. The stem and root may also be attacked directly. The infected area is first water-soaked in appearance; it later becomes sunken and turns a dark reddish-brown. Control is best obtained by planting only in sterilized beds. Beds should be well drained. Soil fungicides applied as a drench around infected plants may be effective.

Wilt (fungus - Fusarium oxysporum f.spp. callistephi): Both young and old plants may be affected. Young plants wilt and die rapidly. Older plants may exhibit two types of symptoms. One side of a plant may be stunted with a yellowing of the lower leaves on that side. When the stem is cut, a brown discoloration of the vascular tissue is found on the infected side of the plant. In the second type of symptom, lower leaves are yellow and wilt. This is followed by wilting and death of the entire plant. Generally this occurs when the plant is in full bloom. The lower portion of the stem may be dark brown when the stem is cut. Most effective means of control is with the use of wilt resistant varieties such as Gem mixed, or Dwarf Queen.

Powdery Mildew (fungus - Erysiphe cichoracearum): This disease is characterized by a white, powdery growth on the upper leaf surface. Older leaves may be affected with little distortion but young leaves become twisted and misshapen. Young growing portions of the plant may be completely infected resulting in dwarfing and curling of the leaves, stems and buds. Often infected buds fail to open. Effective control requires spraying plants with a recommended fungicide at the first sign of disease.

BEGONIA

Begonia spp.

Stem and Root Rot (fungi - Pythium spp., Rhizoctonia spp. and others): Affected plants wilt and break over at the soil line due to decayed spots being formed on stems. This problem is often severe when cuttings are placed in beds for rooting. Fungi responsible for this condition may be introduced on cuttings or be present in soil. Use sterilized soil. Fungicides may be used as a drench. Use cuttings from healthy plants only.

Botrytis Blight and Stem Rot (fungus - Botrytis cinerea): This fungus is most severe when temperatures are cool and moisture levels are high. Affected plants decline rapidly with stems and leaves developing brown, water-soaked lesions. In advanced stages all tissues may be penetrated by the fungus. This disease is especially severe under greenhouse conditions where begonias are propagated. Growers should be sure to start with disease-free cuttings, use a sterilized medium and keep the growing area free of any type of weak or decaying plant material that might serve as a food source for the fungus.

Leaf Spots (fungi - several): Brown spots appear on foliage and reduce plant vigor. Most leaf spotting fungi thrive under high moisture conditions. Change the location of potted plants if conditions are overly wet and use appropriate protectant fungicides.

Powdery Mildew (fungus - Erysiphe cichoracearum): Affected leaves have a white powdery substance on the upper surfaces. This problem is occasional in nature but may occur when environmental conditions are ideal for disease development.

Bacterial Spot (bacterium - Xanthomonas campestris, pv. begoniae): Small blister-like spots appear on leaves. These become clear with age and may run together to form larger spots. Affected leaves may shed prematurely. Chemical control may be only partially effective.

Root Knot (nematode - Meloidogyne spp.): This nematode causes knots to form on roots. This problem can be prevented by using nematode-free planting stock and a sterilized potting medium.

Rust (fungus - Coleosporium solidaginis): Orange-red pustules form on the underside of leaves. In severe cases, foliage turns yellow and dies. Alternate host is pine where it produces a blister rust on the needles. Use rust resistant varieties when available. Fungicides should be used at the first sign of disease and continued on a 7-14 day schedule.

Aster Yellows (mycoplasma): First symptoms are observed as a yellowing or chlorotic appearance along the veins of young leaves. As the chlorosis becomes severe, defoliation occurs. Affected plants do not wilt or die, but have a spindly type growth which detracts from the plants overall appearance. Yellows may attack only a portion of the plant. Secondary shoots are formed profusely on infected plants. The disease is spread by leafhoppers. Control is obtained by insect control and removal of diseased plants.

CACTI AND SUCCULENTS

Many genera and species

Cactus Anthracnose (fungus - *Colletotrichum* (*Gleosporium*) spp.): This disease affects several kinds of cacti, *Cereus*, *Echinocactus*, *Mammillaria*, and particularly *Opuntia* (prickly pear). Infection results in a rather moist light brown rot which shows many light pink pustules on the surface. Spots are small at first, later enlarge and become covered by the small spore-producing pustules. Large areas may be affected, sometimes destroying entire plants. No satisfactory control is available, other than removing and destroying diseased cladodes as soon as noticed. In the greenhouse, soil from infected plants should be removed and benches disinfected. Spraying with a copper fungicide may help in checking the disease.

Charcoal Spot (fungus - *Stevensea* (*Diplotheca*) *wrightii*): Charcoal spot is a common and destructive disease of *Opuntia* in Texas. Small spots, usually one-fourth inches or more in diameter, appear first. The spots are surrounded by a ring of small raised dots that are the fruiting structures. Spots later enlarge, but remain separated. There is no control for infected plants. Remove and destroy diseased specimens.

Dry Rot (fungi - *Phyllosticta concava* and *Mycosphaerella* spp.): Small black circular spots develop first, which later increase in size until they reach a diameter of one or two inches. Further advance is checked by the development of callus tissue. Minute fruiting structures are seen in the infected tissue. The disease is in part physiological, influenced chiefly by soil moisture. Remove and destroy diseased specimens.

Scorch or Sunscald (fungus - *Hendersonia opuntiae*): This disease is common and serious on prickly pear cactus (*Opuntia*). Spots at first are distinctly zoned, later enlarging until entire cladodes turn a reddish-brown and finally die. The center of the disease area is grayish-brown and cracked. Other fungi may also be present in the diseased area. No practical control has been developed.

Cotton Root Rot (fungus - *Phymatotrichum omnivorum*): Several members of the cactus family are susceptible to attack by the cotton root rot fungus. Infected plants die. When pulled from the soil the brown strands of the fungus can be found growing on the root surface. No control practice is available. For additional information, see the section on Cotton Root Rot.

Soft Rot (bacterium - *Erwinia carotovora*): The bacterium enters tissue through natural openings and wounds. Under conditions of high humidity, the bacteria reproduce quickly, spreading to healthy parts of the plant. Diseased tissue is watery, soft, black and deteriorates rapidly. If environmental conditions turn dry, the development of the disease may be checked. The best control is to avoid wounds, treat broken surfaces right away with a copper fungicide and avoid having plants in places where humidity is high.

Nematodes (*Meloidogyne* spp.): Most of the cacti and succulents are susceptible to infection by root knot nematodes. Infected roots show small galls which are typical of the disease and serve to identify it when clean, washed roots are observed. Fumigate or sterilize soil before potting. for additional information, see the Root Knot section.

Other Diseases (fungi): Other fungi known to cause disease on cacti are Fusarium oxysporum (Fusarium rot), Macrophomina phaseolina (Charcoal rot), Septoria spp., Helminthosporium cactivorum, and Aspergillus alliaceus (Stem and branch rot).

Scab (physiological): Particularly common on prickly pear cactus. Rusty colored, corky areas appear on the stems. Scab is thought to be a form of edema, resulting from overwatering and poor ventilation. Increase light and decrease humidity for control.

Stem Rot of Cacti (fungus - Drechslera cactivorum): Basal or top rot of seedling cacti that turns cactus into a shrunken mummy covered with brown spores. First symptoms are yellow spots. It can completely rot a plant in four days. The fungicide Captan should give some control.

CANDELABRA CACTUS

Euphorbia lactea

Stem Rot (fungus - *Coniothyrium euphorbiae*): A disease of *Euphorbia lactea*, especially when grown in greenhouses. The disease begins on the upper end of the branch and moves downward. Rotted areas are dark colored and soft. Once a branch is attacked it usually dies. The disease resembles a bacterial decay, but no foul odor is present. Black fruiting bodies of the fungus can be seen in the infected areas. The fungus becomes established in greenhouses and is spread by splashing water. Damaged or wounded plant are quickly infected. Control by eliminating diseased plants and water without splashing.

CANNA

Canna spp.

Rhizome Rot (fungus - *Sclerotium rolfsii* and *Fusarium* spp.): These organisms cause rhizomes to decay and stems to rot at the base. A cottony fungal growth may be present in rhizome rot.

Bacterial Bud Rot (bacterium - *Xanthomonas cannae*): Young shoots and leaves may be killed. Control of these organisms is through selection of healthy rootstocks. Damaged roots should be discarded. Plantings should be thinned periodically and replanted to increase vigor.

Mosaic (virus): Irregular light- and dark-green areas in leaves. Plants may be stunted and late in flowering. Destroy infected plants and control aphids. The variety - President is immune.

Other Diseases: Include Fungal Leaf Spot (*Alternaria* spp.) and Root Knot Nematodes (*Meloidogyne* spp.). (See the appropriate section for more information on these diseases.)

CARNATION

Dianthus spp.

Fusarium Wilt (fungus - *Fusarium oxysporum* f. spp. *dianthi*): First symptoms are a slow wilting of shoots, often on only one side of the plant. Wilting is accompanied by a discoloration of leaves, at first a light gray-green and finally a pale yellow color. When stems of diseased plants are split, a brown discoloration or streaks are evident in the vascular tissues. Symptoms develop rapidly and are more severe during periods of high temperatures. Most effective methods of control are propagation of disease-free cuttings and complete sterilization of potting soil, tools and benches.

Rhizoctonia Stem Rot (fungus - *Rhizoctonia solani*): Foliage gradually becomes pale and wilted. A wet rot of the bark occurs at the soil line. Rot in the cortex is dry and corky with formations of sclerotia in the center of the stem. Soil sterilization and soil drenches with fungicides are effective methods of control.

Leaf Spot (fungus - *Septoria dianthi*): Small circular light-brown spots with purplish brown border. Occurs on leaves and stems especially on lower portions of the plant. Small black specks (fruiting bodies) develop in the center of the spots. Tips of the leaves may die. Regular applications of a foliar fungicide spray in the greenhouse will control the disease.

Storage Rot or Botrytis Blight (fungus - *Botrytis cinerea*): Primarily a disease of cut flowers. Petals of infected flowers turn brown. May also cause a watersoaked flecking of the outer petals. Will also cause a soft rot of stem ends. Disease usually prevalent under high humidity. Spray or dips will effectively control this disease.

Other Diseases: (See the appropriate sections on Curly Top (virus), and Root Knot (nematode - *Meloidogyne* spp.)

Streak (bacterium - *Erwinia* spp.): This bacterial disease usually starts at flowering time causing purplish-brown streaks on the stems, beginning from the base and extending upwards. The petioles, flowers, flower stalks, and pods are also streaked. Small round spots appear on the leaves running together gradually until the whole leaf is affected. Leaves may become dark brown or be entirely destroyed. Since this bacteria may be carried on the seed, chemical seed treatments and clean seed are advisable.

Other Bacterial Diseases: This host is also subject to crown gall caused by (bacterium - *Agrobacterium tumefaciens*) and leaf spot caused by (bacterium - *Pseudomonas syringae* pv. *pisi*).

Mosaic (Pea Mosaic Virus): Leaves are mottled, curled and yellowish. Flower stalks are short and flowers are streaked with white. Remove and burn infected plants. Control aphids which spread the disease.

Spotted Wilt (Tomato Spotted Wilt Virus - TSWV): Purplish spots on the stems and leaves develop after the leaves are mottled. Discolored or bleached spots may appear on the blossoms. Since the disease is carried by thrips, control the thrips and destroy all infected plants.

Bud Drop Disease: This disease is due entirely to faulty culture; it results in the production of soft succulent growth and a lowered carbohydrate accumulation. A deficiency of phosphorus and potassium in the soil, coupled with low light intensity, are believed to aggravate the condition. If possible, provide extra light in the greenhouse during cloudy weather. Avoid overwatering and overfeeding with high nitrogenous fertilizers.

Root Knot Nematode: See section on Root Knot Nematode.

Nematode other than Root Knot: See section on Nematodes other than Root Knot.

CHRYSANTHEMUM

Chrysanthemum morifolium

Fusarium Wilt (fungus - Fusarium spp.): When this disease occurs lower leaves turn yellow and wilt, followed by overall plant wilting and death of entire plant. Lower portion of stem near soil line turns dark brown-to-black with brown discoloration in vascular tissues. Planting disease-free cuttings, sterilization of potting soil and benches offer best means of control.

Verticillium Wilt (fungus - Verticillium spp.): This disease is mainly in western areas of Texas. General wilting. Leaves become paler green, turn brown and die. Leaves remain attached to stem. In some case, wilting may not occur. First symptoms are a chlorosis of lower leaves which later turn brown. Infected plants are stunted with flowers reduced in size. Control same as for Fusarium Wilt.

Collar or Stem Rot (fungi - Pythium spp., Rhizoctonia spp., Fusarium spp.): Stem turns dark at soil line, entire stem is girdled and plant turns yellow and dies. Control measures include use of sterilized soil, disease-free cuttings, proper drainage and use of a soil drench.

Powdery Mildew (fungus - Erysiphe cichoracearum): Foliage covered with a whitish, ash-gray powdery growth. With severe infectious leaves may become distorted and stunted. Regular foliar fungicide applications will control this disease.

Leaf Spots (fungi - Septoria spp., Alternaria spp., Cercospora spp., and others): Small yellow spots that gradually enlarge increasing to one inch in diameter. Center of spots turn brown. Infection takes place on lower leaves first. Regular applications of a foliar fungicide for control.

Leaf or Foliar Nematode (nematode - Alphelenchoides ritzemabosi): Yellowish-brown spotting of the leaves. Spots are bounded by larger veins. Spots coalesce until entire leaf is affected. Leaves die and fall. Symptoms start at base and progress up plant. Avoid wet humid conditions, do not water from top. Use a peat mulch. Use disease-free propagating material. Phosphate insecticides will control nematode on plant.

Other Diseases: (See appropriate chapter on other nematodes, Southern Blight, Crown Gall, Charcoal Rot, and Cotton Root Rot.)

DAHLIA

Dahlia variabilis

Powdery Mildew (fungus - *Erysiphe cichoracearum*): Whitish-to-grayish growth covering upper surface of leaves. Avoid shaded locations and crowding of plants.

Ring Spot and Mosaic (viruses): Leaves are light green with mottled areas. Veins of leaf may appear light. Plants may be dwarfed and bushy. Leaves may have light green ring spots. Remove and destroy all infected plants as soon as detected. Tubers from virus-infected plants should never be used for planting purposes. Control aphids, leafhoppers and thrips.

Other Disease: Dahlias are susceptible to Verticillium Wilt, Bacterial Wilt, Root Rots, Root Knot nematodes, Charcoal Rot and Southern Blight. In every case, diseased plants should not be used for propagation of new plants. (See the appropriate section for more information on these diseases.)

Tuber Rot (fungus - *Botrytis cinerea*): The most popular method of propagation is root division. To avoid root decay, dust fresh cuts with sulfur.

Flower Blight (fungus - *Botrytis* spp.): In moist weather the buds may be attacked by a soft rot and all infected parts may become covered with the grayish, powdery mold.

Dahlia Mosaic (virus): Infected plants are stunted, yellow and pale green bands will develop along the veins of affected leaves. The leaves may be smaller than normal, wrinkled or blistered.

Dahlia Ringspot (virus): Yellow circles, dime-sized, will develop on the leaves. As time passes these may merge into larger yellow to pale green areas and the centers of the rings may turn brown. This disease is carried in roots and cuttings from diseased plants. Dahlia mosaic and ringspot can also be transmitted by insects.

GERANIUM

Pelargonium hortorum

Cutting Rot (fungi and bacteria): Geraniums are grown from seed but often propagation is done with cuttings. Cuttings are susceptible to invasion by numerous soil-borne organisms, and, thus, treatment of cuttings with a fungicide is often necessary. Allowing the cuttings to "heal" before planting will help reduce stem rot. Wound healing takes place if cuttings are laid on damp sand in heavy shade for approximately three hours. Bacteria (Xanthomonas sp.) and fungi (Pythium sp., Rhizoctonia sp., Fusarium sp., and Botrytis sp.) cause stem rot. They may infect stems singularly or in combination.

Black Leg (fungus - Pythium spp.): Generally a disease of cuttings and young plants. Stems and petioles blacken and a soft rot develops. Rotting starts at the base of the stem and may extend well above the soil line. Plants wilt and die. Symptoms progress rapidly. Control may require sterilizing potting mix and tools. Treat cuttings with a fungicide. A soil drench may retard spread of the disease in propagating benches.

Botrytis Blight (fungus - Botrytis cinerea): Affects blossoms, leaves and stems. On flowers, petals darken at edges and wilt prematurely. Affects central florets first. If humidity is high, spore masses may be found on flowers and leaves. Spots on leaves are irregular, brown and have a water-soaked appearance. Botrytis will cause a soft rot of cuttings. Proper sanitation in greenhouses by removing and destroying infected plant material will prevent spread. Use of a foliar fungicide when conditions are favorable for infection will help to prevent the disease. Improving ventilation and air circulation among the plants will also reduce infection.

Rust (fungus - Puccinia pelargonii): Rust occasionally is found on cultivated geraniums. Distinct, reddish pustules form on the underleaf surfaces in a circular pattern. The upper surface is yellow in areas where pustules form. Control rust by removing infected leaves and spraying with a fungicide.

Bacterial Leaf Spot and Stem Rot (bacterium - Xanthomonas campestris pv. pelargonii): Leaf spots begin as small, water-soaked spots on the underside of leaves. Spots become well defined and slightly sunken in a few days. Necrosis and wilting of the entire leaf follows, but the spots do not coalesce. Another symptom is rapid wilting of the leaf margin resulting in an angular pattern bound by the veins. Stem rot begins with one or two branches showing wilt. Eventually, the entire stem turns black with only a few leaves remaining at the terminals. Within the stem, the vascular fibers remain intact but the support tissue around the fibers is destroyed. Controls consist of using disease-free plants for cuttings, controlling the humidity in greenhouses, avoid wetting leaves when watering.

Viruses: Several viruses are known to affect geraniums. They cause mosaic patterns, mottling, crinkled or cupped leaves. Rogue out diseased plants as soon as they are noticed and use disease-free plants for propagation.

Oedema (physiological): At first, oedema appears as water-soaked spots on bottoms of leaves which later become corky and brown. The leaves may turn yellow and fall off. Oedema is caused by moist, warm soil and moist, cool air or cloudy conditions that result in more water being absorbed by roots than is being transpired by the leaves. As a result, cells swell and burst. Avoid over-watering and increase ventilation.

GLADIOLUS

Gladiolus hortulanus

Fusarium Rot (fungus - *Fusarium oxysporum* f. sp. *gladioli*): Corms decay with a brownish-to-black dry rot of the tissue. The foliage of affected plants first turn yellow and then brown. Roots are killed. When diseased corms are planted, many may rot before producing plants while other produce weak plants that soon die. Before planting, inspect and remove all corms that have discolored areas or lesions. Healthy appearing corm should be chemically treated before planting.

Scab (bacterium - *Pseudomonas marginalis*): Small definitely outlined lesions appear on diseased corms. The lesions are circular, water-soaked and pinpoint to one-fourth inch diameter. A gummy ooze is produced from these spots that is yellow-to-dark brown in color. The lesions are rather shallow. Badly affected plants may die while those less affected have an unthrifty appearance. Mites that occur in the soil seem to serve as a vector and should be controlled with soil treatment if this disease is a problem. Do not plant infected corms. Rotate areas where gladiolus are planted.

Botrytis Blight (fungus - *Botrytis* spp.): Leaves, stems, flowers and corms are infected. Leaf spots are variable in size and shape. Infected flowers decline rapidly and have grayish fungal growth on the surface. The tissues become moist and slimy. Under severe conditions the entire top may be killed. Infected corms have irregularly shaped sclerotia attached to them. Affected corms should be discarded. Use suggested fungicides for controlling the disease on above-ground plant parts.

Other Leaf Spots (Bacterium-Bacterial Leaf Blight - *Xanthomonas* spp.): Water-soaked spots appear on leaves with a bacterial ooze occurring during wet periods. (Fungus - Septoria Leaf Spot - *Septoria gladioli*) Small rot. (Fungus - Stemphyllium Leaf Blight - *Stemphyllium* spp.) Light green-to-yellow lesions form on leaves. Spots turn red.

Virus or Virus-Like Diseases (Virus-Mild Mosaic): Caused by the bean yellow mosaic virus. Produces angular light and dark green mottling of leaves and flower stems. Virus is transmitted by aphids. (Mycoplasma - Aster Yellow) Flower parts remain green and fail to form normal color pigment. Plants turn yellow and degenerate prematurely. (Virus - White Break Mosaic) Caused by the cucumber mottle virus. Causes flowers to be blotched, open slowly and fade early. Plants are stunted. (Virus - Ring Spot) Caused by the tobacco ring-spot virus. Ring spots appear on leaves but flower parts are not affected.

HOLLYHOCK

Althaea rosea

Anthracnose (fungus - Colletotrichum malvarum): This is the most destructive disease on Hollyhock. Fungus attacks leaves, stems and petioles. Typical fungal leaf spots, black blotches on petioles and stems. May also infect lower portions of stems and roots. High temperature and humidity favor development of the disease. Remove and destroy infected plant material and use a regular fungicide application.

Rust (fungus - Puccinia lobata): This is the most prevalent disease on Hollyhock in Texas and all portions of the plant are subject to infection. Small brown spots appear on underside of leaves. On upper leaf surface spots are yellow-to-orange and larger. Spots may coalesce and kill large portions on the leaf. Removal and destruction of infected plant material and regular applications of a fungicide will control rust.

Leaf Spots (fungi - Cercospora spp., Alternaria spp., Septoria spp.): Small angular grayish spots are scattered irregularly over leaves. Dead tissue may fall out leaving a shot hole appearance. Removal and destruction of infected plant material and regular applications of a foliar fungicide.

Cotton Root Rot: (See chapter on Cotton Root Rot.)

Root Knot and Other Nematodes: (See appropriate chapter.)

HYDRANGEA

Hydrangea spp.

Leaf Spots (fungi - *Cercospora* spp., *Phyllosticta hydrangeae* and others): Circular-to-irregular shaped spots are produced on leaves. Use foliar protectant fungicides as needed.

Powdery Mildew (fungus - *Erysiphe polygoni*): A white, powdery substance appears on leaf surfaces. Yellow spots that later turn brown may appear on the upper surface. If allowed to develop, it may get into newly developing buds and cause stunting. Use a foliar fungicide that has the ability to control powdery mildew.

Botrytis Blight (fungus - *Botrytis cinerea*): Botrytis is probably the most serious fungus attacking this plant because it causes severe problems in the flower buds. Infected flower parts may drop on leaves and cause infection of those structures. Cool, damp conditions with an abundance of fungal spores encourage the condition. This problem is especially severe at times in commercial greenhouses. Dispose of any weak or decaying plant tissue and use appropriate protectant fungicides if necessary.

Ring Spot (virus - Hydrangea ring-spot virus): Pale colored rings may appear on leaves and some varieties may have distorted leaves. Dispose of diseased plants. Commercial plant producers should use tolerant varieties.

Nematodes (nematodes - *Meliodogyne* spp., *Pratylenchus* spp., and *Ditylenchus* spp.): Nematode damage occurs when this plant is set in infested beds. Plants grown in pots would not be affected if nematode-free propagating stock and sterilized soil is used.

IRIS

Iris spp.

Leaf Spot (fungus - *Cladosporium iridis*): Irregular, eye-spots which vary in size and run together. They have a grayish center with dark brown borders. The disease usually is more or less confined to the upper surface of the leaf. Carefully remove and burn old iris leaves in the fall or early spring.

Leaf Spot (fungus - *Heterosporium gracile*): Common leafspot of iris in Central Texas. Disease shows up on both upper and lower leaf surfaces as 1/8 to 3/8 inch diameter, irregular spots with dark brown centers and outer edges. Remainder of spot is light tan. Good sanitation is best control. Removal and burning of old leaves each fall is desirable.

Basal Rot (fungus - *Fusarium oxysporum*): This soil fungus enters the roots of bulbous iris and then penetrates the base of the plant and the scales of the bulb. Bulbs should be dried rapidly to avoid possible injury. Cull and discard damaged bulbs.

Soft Rot (bacterium - *Erwinia carotovora*): A foul-smelling soft rot of the rhizome. At first, the leaves begin to turn brown and dieback progresses until the entire plant is dead. The disease is favored by wet, heavy soils or shady locations that tend to keep the ground continuously moist. Plant iris in a well-drained soil and avoid crowded conditions in the bed. In the fall, destroy all dead leaves and plant residue in the iris bed. In season when soft rot is severe, take up the rhizomes in August or September. Cut out the destroy all rotted portions of the rhizomes. Plant in a new location or sterilize the soil. Avoid excessive watering during the growing season. The disease is easily spread to new iris plantings during lifting and dividing operations by spades and other tools. Control iris insects such as the iris borer.

Rust (fungus - *Puccinia* spp.): Rusty-red, powdery pustules break out on both sides of the leaves, causing considerable damage to many varieties. Destroy all fallen leaves before growth starts in the spring.

Mosaic (virus): Yellow striping or mottling of the leaves and flowers. The potato and peach aphids transmit this virus. Discard all infected plants. Control aphids that transmit the virus.

Other Disease: Iris are attacked by several species of nematodes and *Sclerotium rolpii*. (See discussion in other sections for more information.)

PEONY

Paeoniae spp.

Botrytis Blight (fungus - Botrytis paeoniae): Most common disease of peony. Young shoots in all stages of growth, including the buds may suddenly wilt and fall over. Upon examination, a brown or blackish rot is seen at the base of the stem. This discoloration may extend down through the roots. Small buds attacked by the fungus turn black and dry up. Larger buds turn brown and may be covered with a brown spore mass. Large irregular dark brown lesions may occur on the leaves. Cool, rainy weather favors disease development. Splashing rain and insects spread the disease. Regular applications of a foliar fungicide, a drench, and destruction of infected plant material are recommended control measures.

Root and Stem Rot (fungus - Phytophthora cactorum): Infected parts are dark brown to black and leathery. Cankers appear along the stems and may cause them to fall over. May also cause a watery crown rot often destroying the entire plant. Roguing and destroying all infected plants is the only means of control.

Wilt (fungus - Verticillium albo-atrum): Plants gradually wilt and die during the blooming season. Brown discoloration of the water conducting tissues may be seen in cross sections of the roots or stems. Obtain disease-free plants, remove and destroy infected plants. Potting soil should be sterilized.

Mosaic (virus): Circular areas consisting of concentric bands of alternating dark and light green on leaves. Small necrotic spots may also form. Plants are not dwarfed. No control other than destroying infected plants.

Cotton Root Rot: (See section of Cotton Root Rot.)

Southern Blight: (See section on Southern Blight.)

Root Knot and Other Nematodes: (See Root Knot and other Nematodes.)

Leaf Spot (fungus - Alternaria spp.): Leaves may have brown purplish or reddish irregular shaped spots. Leaves may yellow, wither and fall early.

Crown Gall (bacterium - Agrobacterium tumefaciens): See section on Crown Gall.

Powdery Mildew (fungus - Erysiphe polygoni): Powdery, white mold on leaves. Leaves may be deformed, turn yellow and drop early. Collect and destroy fallen leaves and provide adequate spacing of plants.

Ring Spot (virus): Plants may be severely stunted with lemon-yellow to orange-amber spots, blotches or zoned rings. Young leaves may be distorted and plants may not flower. Do not propagate from infected plants.

PERIWINKLE DISEASES

Vinca rosea

Pythium Root and Stem Rot (fungus - *Pythium* spp.): Lesions produced on stems and roots with rapid progression of symptoms. Infected plants die soon after infection. Avoid overwatering and use suggested fungicide.

Other Root and Stem Rots (fungi - *Rhizoctonia solani* and others): Lesions occur on roots and lower stem. Periwinkle is more resistant to this problem than most annuals, but disease can occur when fungi are present in high populations. Rotate plantings and use recommended soil fungicides if needed.

Aster Yellows (mycoplasma): Infected plants are chlorotic and stunted. Control leafhoppers that transmit the disease-causing entity and rogue infected plants.

Canker and Dieback (fungus - *Phomopsis* sp.): Shoot tips will turn dark brown-to-black and die back to the soil. Favored by rainy weather. Preventative spray of copper fungicide starting in spring on new growth will control the fungus.

Phytophthora Aerial Blight (fungus - *Phytophthora parasitica*): Infection is generally characterized by leaf blight and upper stem deterioration. Infection is distinctly an aerial problem, not involving lower stem and root tissue. In most cases, leaves are shriveled and dull-gray in color. An aerial sunken stem canker can also develop. Symptoms develop rapidly in outdoor planted beds, especially during conditions of prolonged, rainy weather. Bark mulches or other mulch materials might help minimize splash dispersal of infested soil particles. No fungicides are currently cleared for use in control.

PETUNIA

Petunia hybrida

Damping-Off and Stem Rot (fungi - *Rhizoctonia solani*, *Sclerotinia* spp., *Fusarium* spp.): A damping-off or decay of plant at or below the soil line. A dark brown-to-black lesion on stems and crown. Use sterilized potting mix. A fungicide drench will help prevent spread.

Mosaic (virus - TMV): Crinkled leaves with yellow and green areas. Plant may be stunted. Destroy diseased plants. No control.

Crown Rot (fungus - *Phytophthora parasitica*): A black discoloration and dry rot of the crown and lateral branches occurs near the soil line. This is followed by wilting and death of the affected plants.

Aster Yellows (mycoplasma): Plants are yellowish, bushy, and dwarfed with many rosette-like, secondary shoots. Flowers often malformed and greenish. Leaves may curl, turn yellow or purple.

Root Knot (nematode - *Meloidogyne* spp.): See section on Root Knot.

PHLOX

Phlox spp.

Leaf Spots (fungi - *Ascochyta* spp., *Cercospora* spp., *Macrophoma* spp., *Phyllosticta* spp., *Ramularia* spp., *Septoria* spp., and *Stemphylium* spp.): *Septoria divaricata* is among the most common and most destructive. It attacks primarily the lower leaves, producing dark brown, circular spots up to one-fourth inch in diameter, the centers of which are light gray, almost white. Infected leaves dry up and die prematurely. For control, spray periodically with recommended fungicides and burn infected leaves.

Powdery Mildew (fungi - *Erysiphe cichoracearum* and *Sphaerotheca humuli*): White or grayish moldy growth on upper side of older leaves. Leaves gradually die, beginning on the lower part of the plant. For control, spray with recommended fungicides as soon as the mildew appears.

Rust (fungi - *Puccinia douglasii* and *Uromyces acuminatus* f. spp. *polemonii*): Neither rust is important enough to warrant control. Both rusts appear on leaves as raised blisters or pustules covered with a brown coating that ruptures releasing the brown spores.

Cotton Root Rot: See section on Cotton Root Rot.

Crown Rot (fungi - *Sclerotium* spp., *Rhizoctonia* spp. and *Thielaviopsis* spp.): These fungi are destructive on seedlings. They cause a rotting of the plant at the soil line. Sterilizing potting soil is the best control.

Wilts (fungus - *Verticillium albo-atrum*): See section on Wilts.

Crown Gall: See section on Crown Gall.

Aster Yellows (mycoplasma): Flower petals often show white steaks and vein banding. Clusters of flowers or individual petals may turn into green, leafy structures.

Stem Blight (fungus - *Pyrenochaeta* spp.): Base of stem and roots may rot. They may be covered with a cottony mold. Avoid overwatering, overcrowding and planting in heavy, poorly drained soil.

Physiological Diseases: No organisms are associated with this condition. The disease is characterized by death of the lower leaves from the base progressively upward until the entire shoot is killed. The disease is most severe on old clumps and is entirely absent on seedlings or newly rooted cuttings. The trouble seems to be caused by excessive transpiration.

Root Knot Nematodes: See section on Root Knot Nematodes.

SNAPDRAGON

Antirrhinum majus

Anthracnose (fungus - *Colletotrichum antirrhini*): Large, light colored spots occur on leaves and stems. Spots frequently have black or brownish dots near centers. Entire leaves may be killed and often the whole plant dies from stem girdling. Spore bearing pustules appear as minute black pimples in the spots. Under a microscope, dark brown, hair-like outgrowths are visible on these pustules. Pull and burn affected plants as soon as disease appears. Spray with recommended fungicides to prevent spread. Water by irrigating surface of soil rather than wetting the foliage. Take cuttings only from healthy plants.

Rust (fungus - *Puccinia antirrhini*): Brown, powdery pustules appear on lower surface of leaves. Plants may be stunted and even killed. Propagate from healthy plants or grow from seed. Control insects that carry the fungus spores from one plant to another. Plants should be spaced so that they have plenty of air. Avoid wetting the foliage when watering. Keep greenhouse temperature above 70°F for several days and not below 60°F at night. Where foliage is wet when watering, spray at weekly intervals with recommended fungicide. Good coverage is necessary for best results. Some resistant varieties are available.

Blight (fungus - *Phyllosticta antirrhini*): Cream colored or light brown circular spots appear on the leaves, sometimes surrounded by circles of other colors. The small black fruiting bodies of the fungus develop on the upper surface of the leaves at the center of the spots. Ash-gray spots covered with the black pycnidia develop on stems. These spots enlarge rapidly and turn dark brown. If the spots entirely encircle the stem, the plants wilt and frequently die. All parts of the plants in diseased beds should be removed and burned at the end of the season. Spray with recommended fungicides. Keep leaves dry and space more widely.

Wilt (fungus - *Verticillium albo-atrum*): Infected plants wilt slowly. At first, only certain branches show wilting. Plant in disease-free soil or sterilize soil with steam. When only a few plants appear infected, remove these together with surrounding soil. Water as little as possible to obtain good growth. Cotton burs used for mulch in West Texas may carry the fungus and should be well composted.

Gray Mold (fungus - *Botrytis cinerea*): This fungus causes a wilting of the flower stalks. A development of light brown areas on the stems at the base of the flower clusters. Under moist conditions, the spores of the fungus may develop in light brown or gray masses. Avoid excess humidity. Cut off and burn infected flower-stalks as soon as they are detected. Keep greenhouse and garden plantings free from debris because the fungus can live as a decay fungus under such conditions and its spores may be blown to living plants. Spray with recommended fungicides after the plants have been cut back to force a second crop.

Powdery Mildew (fungus - *Oidium* spp.): Largely confined to greenhouse-grown snapdragons, this mildew forms a white, powdery coating on both leaf surfaces and young stems. Spray with recommended fungicide.

Leaf Spot (fungus - *Cercospora antirrhini*): Previously reported only from Guatemala, this leaf spot was found in Florida in 1958. Spots are circular, 0.5 to 5 mm in diameter, dingy gray to white. No control measures have been developed but fungicides that control *Cercospora* spp. on other crops might be effective.

Root Knot: (See section on Root Knot.)

Southern Blight: (See section on Southern Blight.)

Stem and Root Rot: (See section on Stem and Root Rot.)

Cotton Root Rot: (See section on Cotton Root Rot.)

SWEET PEA

Lathyrus odoratus

Anthracnose (fungus - Glomerella cingulata): Leaves, flowers and shoots are at first marked with whitish spots. These spots spread extensively so that the parts attacked finally wilt and die. Seed pods shrivel and lose their color. Heavy infection results in much loss of leaves. The wilting works downward from the tips of the younger shoots, which become whitish and sometimes break. With a hand lens, many small salmon-colored pustules bearing great quantities of spores can be seen on the diseased parts. Gather and burn all infected plant parts after the flower season. Choose only seed pods which are plump and sound in appearance for planting. Seed for planting should be selected from disease-free pods. An occasional application of fungicide during the growing season helps minimize disease.

Powdery Mildew (fungus - Microsphera alni): Whitish, powdery growth on upper side of leaf surfaces. Leaves shrivel and drop off. Dust with sulfur or spray with recommended fungicide.

Downy Mildew (fungus - Peronospora trifoliorum): Under moist conditions, the leaves become covered with a grayish moldy growth. Thick-walled, brown resting spores develop within the moldy tissue. Since this is not a serious disease of this host in America, control measures have not been developed.

Leaf Spots (fungi - Colletotrichum pisi, Isariopsis griseola, Phyllosticta orobella, Mycosphaerella pinodes): Infection is not normally severe and spotted leaves can be picked off and destroyed as soon as they appear.

Stem and Root Rot: See section on Stem and Root Rot.

White Mold (fungus - Ramularia deusta f. spp. odorati): This mold, which may cover both sides of the leaves, may be mistaken for powdery mildew. Faint, dull-colored, irregular, elongated spots, which may be somewhat sunken, appear. The spots on the leaf margins, at first water-soaked in appearance, later have a reddish-brown discoloration. Tufts of spore-bearing hyphae develop from the stomatal openings between the epidermal cells. Spray with recommended fungicide as soon as white mold is noticed.

Fasciation (bacterium - Corynebacterium facians): Dense witches' broom, distortions and fasciations develop at the base of the stem or from below the soil line. Since the pathogen is seed-borne, plant clean seed.

TULIP

Tulips gesneriana

Bulb, Crown and Root Rot (fungi - *Penicillium* spp., *Sclerotium rolfsii*, *Pythium* spp., *Fusarium* spp., *Rhizopus stolonifer*, *Rhizoctonia solani*, *Aspergillus* spp.): Tulips may not come up or leaves may be yellow or reddish, stunted, and die because the bulb is rotted. Root may be slimy, soft, dry, hard or powdery in texture. Color may be dark or light gray, black or brown with moldy growth on bulb or scales. Remove and destroy infected plants. Avoid bruising in handling bulbs. Plant clean disease-free bulbs. Water and fertilize properly.

Botrytis Blight (fungus - *Botrytis cinerea*): Leaves and petals are affected with a brown decay, which often destroys large areas. Buds are sometimes blighted, or the flower stalks may tip over from a spot on the side where the fungus has attacked. A brownish-gray, powdery mold is produced on the surface of affected parts. All affected parts should be gathered and burned as soon as possible. Badly affected bulbs should be destroyed. Tulips should not be planted the next year in soil where this disease has been abundant. Plant grown in the greenhouse should be kept well ventilated.

Virus Diseases (Tulip breaking, Mosaic): Flowers may show changes in color with breaking, streaking, greening or darkening. Leaves and flower stems are mottled or streaked with light green or yellow areas. Plants are stunted and have poor vigor. Viruses are spread by cutting flowers and by several species of aphids. Destroy diseased plants when found. Control insects and weeds.

VIOLET AND PANSY

Viola odorata and Viola tricolor

Leaf Spots (fungi - *Alternaria violae*, *Cercospora violae*): Chlorotic spots on lower leaves, centers later turn brown. Usually on lower leaves first. Regular sprays with a foliar fungicide will control the disease.

Anthracnose (fungus - *Colletotrichum violae - tricoloris*): Browning or blotching of leaves. Spots may be small at first, but later enlarge. Spots may coalesce. Sunken, elongated dark brown to black lesions may appear on stems. In severe cases entire plant may be killed. Regular foliar fungicide applications will control this disease.

Scab (fungus - *Sphaceloma violae*): Small, green water-soaked dots. These later enlarge to form circular scabby spots. They may be gray-to-white surrounded by a dark-green border. Lesions may extend along a leaf veins and cause the veins to become distorted. Wilting of the leaves may result from petiole infections. A regular spray schedule with a foliar fungicide will control this disease.

Damping-Off (fungi - *Rhizoctonia* spp., *Pythium* spp., and *Fusarium* spp.): Plants wilt and die suddenly. A dark sunken area may be seen on the stem at or near the soil line. Use sterilized potting soil. Remove and destroy diseased plants.

Cotton Root Rot: See section on Cotton Root Rot.

Southern Blight: See section on Southern Blight.

Root Knot and Other Nematodes: See section on Root Knot and Other Nematodes.

ZINNIA

Zinnia elegans

Bacteria Wilt (bacterium - Pseudomonas solanacearum): This bacterium has been shown to cause a wilt of zinnias in Florida.

Blight (fungus - Alternaria zinniae): Small, reddish-brown spots with grayish centers are the first symptoms of this widespread and highly troublesome disease. Dark brown cankers also occur on the stems. Flowers are spotted and at times completely blighted. Because the causal fungus may be carried with the seed, treat the seed before planting with hot water at 125°F for 30 minutes. Then cool and dry. Older seeds are more easily injured by this treatment. Use recommended protectant fungicide.

Powdery Mildew (fungus - Erysiphe cichoracearum): Whitish powdery growth on leaves and stems. Leaves die from base of plant. Affected plant lose vigor and cease growth. Spray with recommended fungicide as soon as mildew appears.

Leaf Spot (fungus - Cercospora zinniae): Small, roundish spots with gray or whitish centers. Several spots may run together, killing the entire leaf. Spray with recommended fungicides two or three times during the season.

Viruses: Many virus diseases affect zinnias. Among the most prevalent are curly top, caused by curly top virus; mosaic, caused by the cucumber mosaic virus; and spotted wilt, cause by the tomato spotted wilt virus. Remove and destroy infected plants. Spray with insecticides every few weeks to control sucking insects which spread the viruses.

Stem and Root Rot: See section on Stem and Root Rot.

Charcoal Rot: See section on Charcoal Rot.

Nematodes: Two species of nematodes infest this host: Meloidogyne incognita, which causes root knot; and Aphelenchoides ritzema-bosi, which causes angular spots on the leaves. For control see sections in this book dealing with nematodes.

Other Diseases: Zinnias are subject to other diseases including a blossom blight caused by a fungus, Choanephora spp., stem canker by Botrytis cinerea and damping-off by Rhizoctonia solani.

Consult the Chemical Control Supplement (B-1140A) for specific chemical control suggestions.

GROUND COVERS

AJUGA

Ajuga reptans

Root Knot Nematode (nematode - Meloidogyne incognita): Ajuga is very susceptible to root knot nematode. Infected plantings will begin to thin-out in spots and plants may die. Roots of infected plants will contain small knots caused by nematode feeding.

Southern Blight (fungus - Sclerotium rolfsii): Southern blight, also called Crown Rot, is a soil-borne disease of ajuga that will be more serious in poorly drained soils. Plants suddenly turn yellow and die in patches during warm, humid weather. Bases of stems rot and turn brown or black. Frequently, a white mold develops in which small reddish-tan bodies (sclerotia) develop. These sclerotia survive the winter and other unfavorable conditions.

ASIAN JASMINE

Jasminium spp.

Crown Gall (bacterium - Agrobacterium tumefaciens): Plants will lack vigor, be stunted and woody galls will form near the base of the plants or on the roots.

Other Diseases (fungi): Other fungi known to cause disease on Jasmine in Texas are Phoma (blossom blight), Colletotrichum gloeosporoides (leaf spot).

CREEPING EUONYMUS

Euonymus fortunei

Anthracnose (fungus - Gloeosporium spp.): Brown lesions on the leaves, in which tiny fungus fruiting bodies may be seen with a hand lens. Apply dithiocarbamate or copper fungicides.

Crown Gall (bacterial - Agrobacterium tumefaciens): Both the stems and roots may have good size galls. Destroy heavily infected plants. Plants will lack vigor and may die back. If only a few galls, prune out and destroy. Sterilize pruner with 70% alcohol or 10% household bleach.

Powdery Mildew (fungus - Oidium spp.): White powdery mold or gray "felt" patches on leaves. Leaves may yellow, curl, and drop early. Prune to thin out shrub. Use preventive fungicide sprays.

Root Knot (nematode Meloidogyne spp.): See section on Root Knot Nematodes.

Other Diseases (fungi): Other fungi known to cause disease on euonymus in Texas are Phymatotrichum omnivorum (root rot), Exosporium concentricum (leaf spot), and Phyllosticta euonymi (leaf spot).

DICHONDRA

Dichondra spp.

Root Rot (fungus - *Alternaria* spp.): Poor drainage and winter cold may cause Alternaria root rot.

Rust (fungus - *Puccinia dichondri*): This rust, under humid conditions, may develop rapidly.

ENGLISH IVY

Hedra helix

Root and Stem Rot (fungus - *Rhizoctonia solani*): The fungus may attack roots, stems and lower leaves. symptoms on lower leaves first appear on those leaves in contact with the soil. Affected leaves are characterized by well-defined water-soaked areas which enlarge rapidly during cool, moist conditions. At first, leaves are dark green, they then wilt and turn dark-brown. Stems and roots may also be attacked. Infected areas are at first water-soaked in appearance and later become sunken and reddish-brown. Best control is obtained by planting only in sterilized beds. Beds should be well-drained. Soil fungicides applied as a drench around infected plants may be effective.

Root Rot (fungus - *Phymatotrichum omnivorum*): Affected plants wilt and die suddenly. Leaves of infected plants turn brown and remain on the plant. (For further information see section on Cotton Root Rot.)

Anthracnose (fungus - *Colletotrichum omnivorum*): A common disease of English ivy. Infected leaves have large tan-to-dark brown spots with a darker border. The center of infected areas may have small black spots formed by pycnidia (fruiting bodies of the fungus). Spots range in size from one-eighth inch to one-half inch in diameter. As the spots age, the centers may dry up and fall out giving a shredded or shot hole appearance. The fungus may also infect stems causing dark, sunken lesions. In some instances, the stem may be completely girdled causing death of the distal portion. Infected leaves should be picked off and destroyed. Avoid overhead watering. Foliar fungicide application at regular intervals are effective.

Bacterial Leaf Spot (bacteria - *Xanthomonas* spp.): Circular spots which are, at first, light green water-soaked areas. As the spots enlarge, they become brown-to-dark brown with red margins. Eventually, the center of the spots dry and crack. Young twigs and petioles are also attacked. Infection on stems and petioles causes a blackening and shriveling of the tissue. Cankers form and may girdle the stem. Tips of growing portions of the plant turn black and this blackening may extend downward into the older wood. Infected plants may fail to grow normally and have pale yellow-green foliage. Remove and destroy all infected plant tissue. Avoid overhead watering, overwatering and high temperatures, if possible.

Leaf Spots (fungi - *Ramularia hedericola*, *Macrophoma* spp., *Glomerella cingulata*, *Phyllosticta concentrica*): Brown lesions will occur on the leaves and may also infect the stem, causing girdling, collapse and death of apical portion. Infected leaves can be picked off and burned. Remaining foliage should be sprayed with a fungicide.

Sooty Mold (fungus, *Capnodium* sp., and others): The sooty mold fungus may develop on English ivy growing beneath certain trees. This mold lives on secretions of aphids and scale insects which fall from the tree above. This mold seldom causes damage. Control insects to prevent this problem.

Root Rot (fungus- *Phymatotrichum omnivorum*): This is the same fungus that causes cotton root rot.

HONEYSUCKLE

Lonicera spp.

Honeysuckle is a hardy plant that is not plagued with any major disease. Those diseases reported on honeysuckle rarely become severe enough to warrant control fungicides.

Leaf Spots (fungi - *Cercospora* spp., *Septoria sambucina* and others): Avoid overhead irrigation. If spraying is necessary, apply a recommended fungicide.

Leaf Blight (fungus - *Glomerularia lonicerae*): This fungus blights the leaves during rainy seasons with light-colored, circular spots that can cause leaf death. Control by spraying with recommended fungicides.

Powdery Mildew (fungi - *Microsphaera alni* and *Erysiphe polygoni*): These powdery mildew form a white, powdery coating on both leaf surfaces and young stems. Microsphaera is rather widespread in the United States while Erysiphe occurs primarily in the western United States. Control by spraying with recommended fungicides.

Cotton Root Rot (fungus -*Phymatotrichum omnivorum*): Honeysuckle is only moderately susceptible to cotton root rot. (See section on Cotton Root Rot.)

Rarely Observed Diseases: Honeysuckle is also susceptible to thread blight, caused by the fungus *Pellicularia koleroga*, twig blight caused by the fungus *Phoma mariae*, rust caused by the fungus *Puccinia festucae*, hairy root caused by the bacterium *Agrobacterium rhizogenes*, and crown gall caused by the bacterium *Agrobacterium tumefaciens.*

Leaf Spots or Blights (fungus - several): Small-to-large round to irregular spots and blotches on leaves and pods. Leaves may be blighted and drop.

Crown Gall (bacterium - *Agrobacterium tumefaciens*): See section on Crown Gall.

LANTANA

Lantana spp.

Leaf Spot (fungus - Alternaria spp.): Reported in Texas.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Reported on lantana in Texas.

LIRIOPE

Liriope sp.

Leaf Anthracnose (fungus - Colletotrichum sp.): Anthracnose is characterized by brown, necrotic lesions that usually appear along leaf margins and leaf tips. Foliar wetness can intensify infection and subsequent damage. Protective fungicides can help reduce damage if persistent, severe infection occurs.

MOSS PHLOX

Phlox xubulata

Leaf Spot (fungus - Ascochyta phlogis): Remove spotted leaves. spray healthy leaves with recommended fungicide.

Powdery Mildew (fungus): Whitish, powdery mold patches on upper side of leaves and stems from midsummer on. Leaves may shrivel and drop early. Control with recommended fungicides.

Crown Rot (fungi - Sclerotium rolfsii, Sclerotium sclerotirum and Thielaviopsis basicola): Serious losses to phlox seedlings occur from these soil-borne fungi. Start in pasteurized soil.

Root Knot (nematode - Meloidogyne spp.): See section on Root Knot Nematodes.

Root Rots (fungi - Thielaviopsis basicola and Phymatotrichum omnivorum): Not usually serious enough to warrant control.

Rusts (fungi - Puccinia douglasii and Uromyces acuminatus): Not usually serious enough to warrant control.

OXALIS

Oxalis spp.

Rust (fungus - Puccinia sorghi): The importance of this rust on oxalis is that its alternate host is corn. On oxalis, the rust first appears as neat, yellowish dots near the margins of the leaves; later pale orange pustules break out on the leaf. Usually does not cause enough damage to warrant control.

Beet Curly Top (virus): See section on Curly Top.

Powdery Mildew (fungus - Microsphaera russellii): White, powdery blotches on foliage.

Smut (fungus - Ustilago oxalidis): Reported in Texas.

STAR JASMINE

Jasminium spp.

Stem Gall (fungus - Phomopsis spp.): Small galls occur on stem.

Crown Gall (bacterium - Agrobacterium tumefaciens): See section on Crown Gall.

VINCA

Vinca major, Vinca minor

Canker and Dieback (fungus - Phomopsis livella): Shoot tips will turn dark brown-to-black and die back to the soil. Favored by rainy weather. Preventive spray of copper fungicide starting in spring on new growth will control the fungus.

Leaf Spot (fungus - Alternaria spp.): Brown circular-to-oval spots on leaves. Control with copper or other recommended fungicides.

Dodder (Parasitic plant - Cuscuta indecora): See section on Dodder.

Curly Top (virus): See section on Curly Top.

Aster Yellows (mycoplasma): Reported in Texas.

Consult the Chemical Control Supplement (B-1140A) for specific chemical control suggestions.

SHRUBS

ALTHEA (Rose of Sharon)

Hibiscus spp.

Flower Bud Drop (physiological): Open flowers and buds may drop suddenly when one moisture extreme follows another. For example, drought stress followed by adequate moisture may cause such drop. Other extremes in growing conditions may also contribute. Avoid drought stress.

Leaf Spot (fungi - Cercospora spp., Phyllosticta spp. and others): Circular spots occur on leaves which results in their shedding from the plant. Use appropriate foliar fungicides to prevent damage.

Root Knot Nematodes (Meloidogyne spp.): Knots or galls form on roots causing the plant to be inefficient in absorbing water and nutrients. Leaves are small and the plants fail to make normal growth. Use caution when planting to be sure that planting stock is not infested. If yard soil is contaminated, plant shrub in a large container of sterilized soil. This is probably the most serious problem experienced by althea.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Althea is very susceptible to attack by the cotton root rot fungus that occurs in the soils of central Texas. If this disease is a problem in the area, it may be necessary to grow the plant in a large container of sterilized potting mix or soil.

Leaf Rust (fungus - Kuehneola malvicola): Infection by the leaf rust fungus causes chlorosis and leaf spotting. Infection is characterized by yellow-orange pustules on the lower leaf surface. Fungicide control is usually not necessary.

AZALEA

Rhododendron spp.

Anthracnose - Leafspot and Dieback (fungus - *Glomerella cingulata*): Symptoms on leaves are characterized by numerous small, round spots on both leaf surfaces. The spots are light to rusty-brown with a definite margin. Under severe conditions, the spots may coalesce and form large irregular spots. Premature defoliation may occur. Branches may suddenly wilt and die. Upon close examination, stem cankers that have girdled the stem may be observed. Pink pustules or spore masses may be seen in these cankers during moist periods. Plant in well drained soil and avoid excessive nitrogen fertilization. When dieback occurs, prune out and destroy diseased twigs. Preventive sprays with a foliar fungicide are effective.

Petal Blight (fungus - *Ovulinia azaleae*): The first evidence of infection is the appearance of small, brown irregular-shaped spots on the petals. Spots are white on colored flowers and brown on white flowers. Affected petals have a veined appearance and remain firm. Flowers may have a freckled appearance. The flower collapses and sticks to the foliage. Small, black fruiting bodies (sclerotia) form on blighted flowers. Where flower blight has previously occurred, spray soil and litter around plants with a recommended fungicide four weeks before bloom. Spray at regular intervals during the blooming period.

Leaf Spot (fungi - *Cercospora* sp., *Phyllosticta* sp.): Spots of various sizes and color on leaves throughout the year. Fungicidal sprays at 7-10 day intervals during periods of high humidity will prevent serious foliage damage.

Leaf Gall (fungus - *Exobasidium* sp.): Distorted leaf and bud growth developing in April and may. Affected parts later become covered with a whitish mold. Spray plants with protective fungicide just before flower buds open and at 10 day intervals until flowering ceases. Remove and burn affected parts.

Root and Crown Rot (fungus - *Phytophthora cryptogea*): Affected plants may wilt suddenly and die or they may be unthrifty if only a portion of the root system is infected. A brown discoloration of the wood may be seen in the basal portions of the stems and in the main roots. Plants are much more susceptible when planted in poorly drained areas or planted too deeply. Plant only in well-drained and well-aerated soil. Plant only as deep as the plants originally grew. Drench with a soil fungicide before plants are seriously affected.

Physiological Disorders: Leaf margins and leaf tips turn brown. Plant are unthrifty or fail to grow. Principal cause is improper soil moisture relationship; i.e., soil allowed to become too dry or soil waterlogged to exclude oxygen. Contributing factors may be salt toxicity from over-fertilization, "root-bound" plants unable to develop normal root systems, soil alkalinity due to leaching of lime from masonry of new residences or the use of alkaline water from certain deep well sources. Select healthy bushes with unrestricted root systems showing active growth for planting. Plant in well-drained soil avoiding sites exposed to full sunlight or to the west sun. Maintain high amount of organic matter in soil and adequate mulch to preserve uniform soil moisture in the root zone.

Chlorosis: See section on chlorosis.

BOXWOOD

Buxus spp.

Decline, Dieback, Root Rots, Twig Blight, Cankers (fungi - *Armillaria* spp., *Fusarium* spp., *Gandoderma* spp., *Nectria* spp., *Phymatotrichum* spp., *Rhizoctonia* spp.): Infected branches often start growth later in spring than normal ones. Leaves on such branches usually curl upward close to the stem and turn light grayish-green or bronze and finally straw-colored. Leaves may wither and drop early leaving bare twigs. Roots may be decayed. The bark at base of branches may die and slough off. Before growth starts in spring, remove and destroy all leaves on ground and lodged in twig crotches. Prune out dead twigs and severely cankered branches as soon as noticed. Spray with a fungicide just after removing dead leaves and branches and as new leaves begin to develop.

Leaf Spots, Leaf Tip Blights, Leaf Cast (fungi - *Diplodia* spp., *Phoma* spp., *Phyllosticta* spp.): Leaves variously spotted may become pale or straw-colored, sometimes dull tan or brown, starting at margins and tips. Many leaves drop early. Young twigs may die. Begin spraying with a foliar fungicide as new leaves emerge.

Nematodes (Lesion, Ring, Stubby Root, Stunt and Root Knot): Plants are weakened, stunted and lack vigor, may wilt on hot days and recover at night. Leaves may be pale green to bronze or orange. Plants gradually decline and branches may die back. Roots will be stunted, often bushy, dark and may have knots or galls on them. Fumigate planting site before replanting boxwood in infected soil.

Root Knot (nematode - *Meloidogyne* spp.): Plants usually lacking vigor are often stunted and yellow. Small-to-large swellings, galls or knots develop on the roots. These are usually round and cannot be broken off like nodules on legume roots. This is a major limiting factor in growing boxwood.

Root Rot (fungus - *Phytophthora cinnamomi*): Foliage has an off-color followed by sudden wilting and death of the entire plant. Usually infected plants cannot be saved.

Winter Injury (non-pathological): Leaves may turn bronze colored, rusty brown or red with dead areas around margins. Leaves will usually begin to dry in the late spring. Leaves, twigs and even entire plants may die back. Plants that are not watered during the wintertime are more susceptible to winter injury. Using mulches around the plants will help prevent freezing.

CAMELLIA

Camellia japonica

Canker and Dieback (fungus - Glomerella cingulata): Sudden wilting of branches is usually the first indication of disease. Gray blotches appear on bark of stem or branches. Underlying wood dies and bark may split to form open wounds or cankers. Pinkish pustules or spore masses may be seen in these cankers during moist periods. Leaves on affected branches turn chlorotic and branch tips die back. Plant in well-drained soil that has the proper pH and fertility level. Avoid excessive nitrogen fertilization. When dieback occurs, prune out and destroy diseased twigs. Prune several inches below visible canker, and use a commercial wound dressing on all cuts. Spraying plants during wet periods and during the period of normal leaf drop with a fungicide will help control the disease.

Petal Blight (fungus - Sclerotinia camelliae): Petal blight affects only the flower portion of the plant. The first evidence of infection is the appearance of small, brown, irregular-shaped spots on the petals. Affected petals have a "veined" appearance and the tissue remains firm. Entire flower turns brown in 24-48 hours and usually drops. The disease generally occurs during the spring. Remove and destroy all infected plant tissue. Apply fungicide to the soil just prior to bloom to prevent germination of overwintering spores. Thoroughly cover all areas under the plant and at least a 10 foot radius around each plant. Applications of a foliar fungicide at the first sign of disease and at 7-14 day intervals is effective.

Leaf Gall (fungus - Exobasidium camelliae): Young leaves and buds may be infected. Leaves become thickened and succulent and may be larger than normal. The color changes from light green to nearly white. Little damage occurs but the plant appears abnormal or diseased. Pick young galls and destroy. Spray with fungicide before leaves open.

Leaf Spots (fungi - Phyllosticta camelliae, Pestalotia guepini and algae - Cephaleuros virescens): Various sized spots on the leaves. Small, black pinpoint dots may be in the dead leaf areas. Control requires preventive fungicidal sprays at two week intervals. Include a spreader sticker to increase effectiveness of sprays.

Ring Spots (virus): Occurs mostly in East Texas. Light green or yellowish rings surround islands of green in the leaves. Destroy diseased plants. Propagate from disease-free plants.

Yellow Mottle Leaf (virus): Irregular, yellow patterns on some leaves. No cure available. Propagate from disease-free plants.

Bud Drop (physiological): May occur as a result of overwatering, inadequate moisture in the soil, insufficient light, excessively high temperatures, severe freezing during the winter or a pot-bound condition of the roots. Also, certain camellia varieties shed their unopened bloom buds as a result of insufficient cold during the winter. Fertilize and water properly. Keep plants healthy by controlling diseases and insects.

Oedema or Scab (physiological): Corky bumps or raised areas on leaves.

Usually due to excessive water in soil.

Sunburn (physiological): Leaves have brown or faded green areas. Occurs on side of bush directly hit by the sun. Particularly a problem on bushes transplanted from a shaded to a sunny location.

Salt Injury (physiological): Margins of leaves turn light brown and dry. Camellias cannot tolerate high soil salinity.

COTONEASTER

Cotoneaster spp.

Fire Blight (bacterium - Erwinia amylovora): New shoots suddenly appear as if scorched by fire. Brown or blackened leaves cling to twigs. Slightly sunken, girdling, discolored cankers on twigs, branches and trunk. Prune and burn affected parts.

Leaf Spots (fungi - Entomosporium maculatum, Phyllosticta cotoneastri): With Phyllosticta, leaves will have reddish-brown spots bordered by darker zones, outside of which is a zone of dark red. There may also appear within the spots small, black fruiting structures of the fungus.

Canker (fungus - Physalospora obtusa): This fungus causes cankers and twig blight on cotoneaster. Prune and destroy infected branches.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): See section on Cotton Root Rot.

CRAPEMYRTLE

Lagerstroemia indicia

Powdery Mildew (fungus - Erysiphe lagerstroemiae): Powdery mildew is very common on crapemyrtle. It is particularly active in the spring and fall months. White-to-grayish moldy growth develops on leaves and new shoots. Dust or spray with a recommended fungicide at first appearance of mildew. Dallas red is an old variety with good mildew resistance. Check on availability of newer varieties with mildew resistance.

Leaf Spots (fungi - Cercospora spp., Phyllosticta spp.): Leaf spot fungi seldom cause severe damage. If needed, apply a recommended fungicide.

Cotton Root Rot: See section on Cotton Root Rot.

Mushroom Root Rot: See section on Mushroom Root Rot.

ELAEAGNUS

Elaeagnus spp.

Wet Feet (physiological): Elaeagnus (Russian olive) is a hardy woody shrub with few disease problems. It is, however, vulnerable to excessively wet soils. Elaeagnus should be planted on well-drained sites and not in low spots or in soils that retain water.

Leaf Spots (fungi - *Cercospora carii*, *Cercospora elaeagni*, *Phyllosticta argyrea*, *Septoria argyrea*): Spots may vary in size, color and shape. These fungi are rarely severe enough to warrant control measures. Prune out heavily infected foliage if it becomes unsightly.

Southern Blight (fungus - *Sclerotium rolfsii*): Southern blight primarily attacks elaeagnus in the seedling stage. Plants usually wilt as the stems rot at or below the soil line. A white, cottony mold may be evident on the lower stems near the ground line. Brown fruiting bodies (sclerotia) are often scattered through the cottony fungus growing on the stem. This disease does not normally attack older plants.

Cotton Root Rot (fungus - *Phymatotrichum omnivorum*): As with most woody ornamentals, elaeagnus will die quite rapidly when infected with the cotton root rot fungus. Plants will die so rapidly that leaves are not shed but are retained on the plant. Cutting the base of the plant with a knife soon after it dies will show that the base of the plant and the roots died before the upper part of the plant. The woody portion of the crown will be darker than in the branches and stems. No controls are known.

EUONYMUS

Euonymous spp.

Powdery Mildew (fungi - Oidium euonymi-japonici and Microsphaera alni): Powdery mildew is the most common and possibly the most difficult disease to control on euonymus. It forms a flat, whitish growth on the leaves which can be easily rubbed off. Leaves may yellow slightly and drop off, but heavy defoliation is not a characteristic symptom. The fungus only invades the epidermal cells and, thus, leaves normally stay attached long after they are infected. Preventing infection of the new growth in the spring and planting in a proper site are keys to controlling powdery mildew. Cultural controls include: (1) planting in a sunny area; (2) not crowding the plants; (3) avoiding overhead watering; (4) pruning out and destroying heavily disease branches; and (5) raking and destroying fallen leaves. Chemical applications should begin before new foliage is infected. Fungicides will protect foliage from infection but will not remove the dense, white fungal growth from infected leaves. Adding a wetting agent to the spray solution will greatly improve coverage. Liquid household detergents make good wetting agents when one teaspoon is added for each gallon of spray solution.

Crown Gall (bacterium - Agrobacterium tumefaciens): Large, rounded galls with an irregular rough surface, appear on roots or stems. Plants lack vigor and may die back. Avoid wounding stems or roots. Prune out and destroy affected plant parts. Sterilize pruning shears in 90% alcohol or 10% bleach after each cut. Dig up and destroy severely affected plants.

Anthracnose (fungus - Colletotrichum spp.): Symptoms consist of small, brownish spots on the leaves with light colored centers. Tiny cracks in the leaf spots indicate fruiting structures of the fungus. Overhead watering makes the disease worse and considerable defoliation can result. Fungicide applications will help control this disease.

Leaf Spots (fungi - Cercospora destructiva, Phyllosticta euonymi, Septoria euonymi): Various sizes and colored spots on leaves. Collect and burn fallen leaves. Prune to thin out shrubs. Protect with fungicide sprays when needed.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Plants suddenly wilt and die. when plants are removed from the soil, the bark on the roots is decayed. See section on Cotton root rot for more information.

Oedema (physiological): Small, raised masses of tissue on the underside of leaves. the raised mass of tissue later becomes rough and corky. May sometimes occur on stems. Control by reducing moisture level. In greenhouses, reduce humidity, improve air circulation and avoid overwatering during overcast periods.

GARDENIA (CAPE JASMINE)

Gardenia jasminoides

Canker (fungus - Phomopsis gardeniae): One of the most common gardenia diseases. The main stem is swollen near or below the soil line. The bark becomes corky and contains numerous longitudinal cracks in the cankered area. The stem above the canker is bright yellow in contrast to normal greenish white. If the humidity is high, a yellowish exudate may be seen on the surface. Affected plants are stunted and die slowly. Destroy all diseased plants to prevent spread of the disease. Place new plants in a different location. Disease is easily spread on propagating knives.

Bacterial Leaf Spot (bacteria - Pseudomonas gardeniae, Xanthomonas campestris cv. maculifolium-gardeniae): Small, rounded ovoid spots on young tender leaves. As the spots enlarge, the center is at first pale yellow and later become reddish-brown surrounded by a yellow halo. Margins of the lesions are thickened and water-soaked in appearance. Spots may coalesce to form large, irregular-shaped spots. Severe infection may cause defoliation. Avoid overhead watering. The disease is spread by taking cuttings from infected plants. Use sterilized soil and pots.

Rhizoctonia Leaf Spot (fungus - Rhizoctonia spp.): Leaves have tan to brown spots up to one-fourth inch in diameter. Spots are circular and zoned. The disease begins on the older leaves and spreads upward when the plants are watered excessively or when air circulates poorly because of overcrowding. Diseased leaves should be destroyed and sterilized soil should be used. Disease-free plants should be used for propagation. Avoid wetting foliage when watering.

Leaf Spot (fungi - Cercospora spp., Phyllosticta spp.): Spots of various sizes on leaves throughout the year. Spots may be small, dark-brown necrotic areas surrounded by a yellow halo. In severe cases, premature leaf drop may occur. control is obtained by spraying with a foliar fungicide at regular intervals.

Sooty Mold (fungus - Capnodium spp.): Black, thin layers of the fungus form over the upper surface of leaves. Sooty mold is caused by a fungus that grows on sugary exudate from white flies. Control white fly.

Bud Drop: Abnormal dropping of buds. Occurs during period of high night temperatures or during periods of low light intensity. Some bud drop is a natural condition. *Every effort should be made to keep the soil uniformly moist, but not wet, during flowering.*

Powdery Mildew (fungus - Erysiphe polygoni): White powdery spots on leaves. Use preventive fungicide.

Other Diseases: Root Knot Nematode, Cotton Root, Crown Gall, and Mushroom Root Rot. (See appropriate sections.)

HOLLY AND YAUPON

Ilex spp.

Leaf Spots (fungi - Cercospora spp., Phyllosticta spp.): Brown or purple spots occur on leaves. Spray with recommended fungicides at 7-10 day intervals. Include a spreader-sticker or detergent in spray mix to help wet leaves thoroughly.

Chlorosis: See section on Chlorosis.

Cotton Root Rot: See section on Cotton Root Rot.

Mushroom Root Rot: See section on Mushroom Root Rot.

Sooty Mold: See section on Sooty Mold.

Nematodes Other Than Root Knot: See section on Nematodes Other Than Root Knot.

Winter Injury: See section on Winter Injury.

LIGUSTRUM

Ligustrum spp.

Anthracnose (fungus - *Glomerella cingulata*): Leaves dry out and cling to the stem. Twigs are blighted and cankers are formed at the base of the main stem. cankers may be spotted with pinkish pustules. The bark and wood of diseased portions become brown and the bark on the cankers may split, exposing the wood, Death occurs when the cankers completely encircle the twigs or stems. The following varieties are resistant: Amur privet, *L. amurense*; Ibota privet, *L. ibota*; regal privet, *L. ibota regelianum*; and California privet, *L. ovalifolium*. For climates in which winter killing is not a factor, the California privet is preferred for planting.

Green Scurf (alga - *Cephaleurus virescens*): Green scurf or algal leaf spot appears on twigs and limbs. Spray or dust with a copper fungicide recommended for general use on ornamental plants being careful to cover the underside of the leaves. Add a spreader-sticker to the spray.

Leaf Spots (fungi - *Exosporium concentricum*, *Cercospora adusta*, *Phyllosticta ovalifolii*): Brown or dark colored spots occur on the leaf. Generally not serious. Usually occurs during very rainy seasons or more frequently in overcrowded, poorly aerated plantings. Most prevalent just before normal fall of old leaves.

Sooty Mold: A blackish growth occurs on the leaves. Commonly follows white fly infestation. Control white flies.

Crown Gall: See section on Crown Gall.

Chlorosis: See section on Chlorosis.

Cotton Root Rot: See section on Cotton Root Rot.

Mushroom Root Rot: See section on Mushroom Root Rot.

Root Knot Nematode: See section on Root Knot Nematode.

Winter Injury: See section on Winter Injury.

Gall (fungus - *Phomopsis* sp.): Galls develop rapidly reaching a diameter of one and one-half inches within five and one-half months. These galls are commonly mistaken for bacterial galls. Prune out the galls. Pruning shears need not be sterilized as they will not infect a pruning cut.

NANDINA

Nandina domestica

Leaf Spots (fungi - Cercospora nandinae, Glomerella cingulata): Small, circular spots develop on the foliage. Lesion is brown-to-dark brown with reddish halo. Fungicides not required. Sanitation will help reduce foliage infection.

Ring Spot (virus): Light green or yellow, irregular rings occur in leaves. Plants tend to be smaller and low in vigor. Destroy diseased plants. Propagate from healthy plants.

Iron Chlorosis (nutrient deficiency): Foliage becomes light green and finally a greenish yellow. The veins tend to remain green. Foliar applications of iron sulfate or copperas are usually effective if several applications are made when leaves are forming. For mid- or late season corrections of a severe deficiency apply iron chelates such as Geigy 330 Fe (Central Texas) or Geigy 138 Fe (West and Far West Texas).

Cotton Root Rot: See section on Cotton Root Rot.

Root Knot Nematode: See section on Root Knot Nematode.

PHOTINIA

Photinia spp.

Leaf Spots (fungi - Entomosporium maculatum, Cercospora heteromeles, Phyllosticta heteromeles): Spray at 7-10 day intervals during wet or humid weather with a recommended fungicide. Expanded, brown and often zoned spots on the leaves. The leaf spots may be round-to-irregular, purple, then gray-to-brown with purple margins in which black specks can later be found.

Powdery Mildew (fungi - Podosphaera leucotricha and Sphaerotheca pannosa): Dust or spray with approved powdery mildew fungicide when mildew first appears. Repeat at 10-14 day intervals as long as necessary. Preventive sprays in following years would produce better control.

Cotton Root Rot: See section on Cotton Root Rot.

Mushroom Root Rot: See section on Mushroom Root Rot.

Root Knot Nematode: See section on Root Knot Nematode.

Fire Blight (bacterium - Erwinia amylovora): Leaves, stems and fruit are blighted by this bacterium. New shoots suddenly appear as if scorched by fire. Brown or blackened leaves cling to twigs. Slightly sunken, girdling, discolored cankers develop on twigs, branches and trunk. Follow the same control procedures recommended for pears.

PITTOSPORUM

Pittosporum tobira

Cercospora Leaf Spot (fungus - Cercospora pittospori): Small, angular-shaped, yellowish-to-brownish spots. Spots may coalesce to form large irregular spots. Fungus fruits in fawn colored patches on lower surface. Most prevalent on older leaves. May cause premature leaf drop. Control is best obtained by protective spraying with recommended fungicides.

Leaf Spots (fungi - Alternaria tenuissima, Phyllosticta sp.): Small, circular dark-brown necrotic spots surrounded by chlorotic areas. Generally affects shrubs in poor physiological condition. Control is best obtained by maintaining shrubs in good growing condition. Applications of a protective fungicide are effective.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Plants suddenly wilt and die. When plants are pulled from the soil, the outer bark is decayed. Rhizomorphs of the fungus may be observed. (For additional information, see section on Cotton Root Rot.)

Root Knot Nematode (fungus - Meloidogyne sp.): Plants usually lack vigor, are often stunted and pale yellow. Plants may wilt quickly under moisture stress. Roots have small-to-large swellings, galls or knots. These are generally spherical and cannot be easily removed from the roots. See section on Root Knot Nematode.

Virus: Three virus diseases, a mosaic on the leaves, one which causes a variegation of the leaves and one which causes rough bark have been reported on Pittosporum.

Southern Blight (fungus - Sclerotium rolfsii): Reported in Texas.

POINSETTIA

Euphorbia pulcherrima

Gray Mold (fungus - Botrytis cinerea): This disease is especially serious on double varieties. The inflorescence, leaves and stems are attacked. A gray mold occurs on the inflorescence causing a blasting and browning of the flower clusters and colored bracts. Water-soaked lesions will appear on leaves and stems. In the later stages of the leaf and stem disorder, the lesions become dry and crisp.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Cotton root rot is restricted to extreme South Texas where Poinsettias are planted in landscapes. In most areas of Texas, Poinsettias will not survive winter temperatures. (Refer to Cotton Root Rot section.)

Scab (fungus - Sphaceloma poinsettia): A very common disease of poinsettia, particularly in South Texas. The fungus attacks leaves and stems, starting out as conspicuous, raised lesions or cankers on diseased stems. The cankers are at first white, later turning gray. Frequently, these cankers unite to cover irregular raised areas which give the plants an unsightly appearance. The disease cannot be controlled once it is well established on plants. Severely diseased plants should be cut back and the new growth should be protected with a fungicide.

Black Leg (fungus - Rhizoctonia solani): This disease can affect poinsettias at any stage of growth, but it is usually more prevalent right after the plants are potted. Stems affected by Rhizoctonia become dark-brown, water-soaked, with lesions that extend above and below the soil line. The lesion may encircle the stem, causing the stem to become weak. As a result of the black leg condition, the foliage becomes pale yellow and some of the leaves fall off. If roots and stems become severely infected, the plants die suddenly. Drenching the soil with a fungicide around the base of the plants may help in checking this disease.

Pythium Root Rot (fungus - Pythium sp.): Roots and basal portions of the stem turn brown and soft. Foliage may wilt rapidly. Pythium root rot is a major problem in commercial poinsettia production. Control measures consist of fungicide treatment of soil mix, fungicide drenches, acquisition of clean planting stock, and using a potting medium that drains well.

PYRACANTHA

Pyracantha spp.

Scab (fungus - Fusicladium pyracanthae): Affects both the foliage and berries. It first shows up on foliage as small, greenish-yellow spots which later turn black. The berries are marked by small, black scabby spots. The disease is favored by long periods of intermittent rains and mild temperatures. Primary infection is from the previous year's foliage. Control is obtained by following a regular spray program and sanitation through removal of plant residues.

Fire Blight (bacterium - Erwinia amylovora): Causes twig dieback and blossom blight. Infected blossoms wilt and turn black rapidly. The disease progresses from the blossoms into the vascular system where it causes extensive twig death. The foliage does not abscise due to the rapid rate of death. Twig blight is common and can result in dieback ranging up to 12-24 inches of twig length. Dark sunken areas or cankers are formed on the twigs. Bacteria overwinter in the cankers. In the spring, bacteria ooze from the cankers and are carried by wind, rain and insects to healthy foliage. Shrubs which have fire blight should be pruned to remove infected material. Make cuts four inches below visible cankers. All pruning equipment should be sterilized between cuts with a one part household bleach to nine parts of water. Avoid high nitrogen levels.

Sooty Mold: Black, powdery mold in patches or covering entire upper leaf surfaces. A non-parasitic growth resulting from infestations of aphids or other sucking insects. Use effective insect control.

Root Rots (fungus): Tip burn and/or marginal burn of leaves, often followed by branch dieback or death of entire plant. Frequently associated with poorly drained or waterlogged soils. (See appropriate section on Cotton Root Rot and Mushroom Root Rot.)

ROSE

Rosa spp.

Black Spot (fungus - *Marsonnina rosea* - *Diplocarpon rosae*): Black spots ranging in size from one-eighth to one-half inch or greater in diameter form on leaves. Spots can occur on either leaf surface as well as petioles, twigs and canes. Infected leaves soon turn yellow and drop from the plant. This results in plants becoming weakened to the point where few blossoms are produced and plant life is endangered. Consistent use of protectant fungicides is necessary for black spot prevention in most areas. The fungus persists in fallen leaves and canes. Destroy all fallen leaves and prune infected canes severely during late winter.

Powdery Mildew (fungus - *Sphaerotheca pannosa* var. *rosae*): A white powdery growth occurs on leaves, buds and twigs causing them to be distorted and dwarfed. Young, tender growth is most susceptible. The disease is more likely to occur during cool, dry conditions and can spread rapidly since a complete life cycle can occur in 72 hours. Thousands of spores are produced on a single plant with each having the ability to cause disease. Varieties differ in their susceptibility. Use an appropriate fungicide during times when disease pressure is high.

Dieback and Canker (fungi - *Crytosporella umbrina* and others): Plants weakened by other diseases or adverse growing conditions may be more susceptible to this condition. Organisms invade the stems and cause cankers (dead tissue surrounded by living tissue) to form. These often girdle the stem and tissue past the point of infection is killed. Prune infected limbs and twigs being sure to cut well below the diseased tissue. Disinfect shears in formaldehyde or chlorine solutions between each cut. Keep plants free of other diseases.

Rust (fungus - *Phragmidium* sp.): Rust is an occasional problem that can cause serious defoliation. Small, raised, orange pustules occur on the lower leaf surface. corresponding yellow spots occur on the upper surface. Affected leaves that shed from the plant should be collected and destroyed. Use a suggested protectant fungicide as soon as the first evidence of disease is observed.

Crown Gall (bacterium - *Agrobacterium tumefaciens*): Woody galls form on lower stems and root tissue. If the gall encircles the lower stem or main roots, the plant may be killed. Do not plant nursery stock showing these symptoms. Setting existing plant in raised beds may prolong their life. Sterilizing the soil prior to planting is helpful only if the organism is not introduced on the transplant.

Verticillium Wilt (fungus - *Verticillium* sp.): Plants become unthrifty and die due to plugging of the water and nutrient conducting vessels. Occurs mostly in West Texas. Compost or sterilize gin trash if it is being used as mulch.

Root Knot Nematodes (nematode - *Meloidogyne hapla*): Knots or galls occur on smaller roots limiting the development of the root system. Do not plant stock that is infected. Sterilize soil if plants must be planted in infested areas.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Infected plants die suddenly. Roots may be covered with buff brown strands of fungal growth. Do not replant roses in the same area without soil sterilization.

Virus Diseases: Roses are susceptible to several virus diseases, none of which can be controlled in an infected plant. The more common viruses are as follows:

Rose Mosaic: Variable yellow and green patterns occur in infected leaves. Some patterns may appear to be rather artistic. It appears to be spread from plant to plant only by graft transmission. No serious damage occurs to individual plants; however, grafting or budding should not be done from infected plants.

Spring Dwarf: Symptoms are noticed when leaves first emerge in the spring. Leaves are balled, short and curved. Leaves have cleared veins. Do not propagate from infected plants. Destroy infected plants.

WISTERIA

Wisteria spp.

Crown Gall (bacterium - Agrobacterium tumefaciens): This soil-borne bacterium will sometimes infect wisteria, causing galls or swellings on the main roots or stems. Inspect plants before buying and discard any plants with knots, galls, or swellings on the roots. (See section on Crown Gall.)

Leaf Spots (fungi - Phyllosticta wisteriae, Septoria wisteriae): Different fungi may cause leaf spots on wisteria. Pick off and destroy spotted leaves. Fungicide applications are normally not necessary.

Powdery Mildew (fungus - Erysiphe cichoracearum): A white-grayish mold develops on the surface of the leaves. Spray with a protective fungicide if the disease occurs frequently.

Root Knot Nematode (nematode - Meloidogyne spp.): See section on Root Knot Nematode.)

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Wisteria is moderately susceptible to cotton root rot.

Consult the Chemical Control Supplement (B-1140A) for specific chemical control suggestions.

RATING OF ORNAMENTAL PLANTS TO ROOT-KNOT NEMATODES

ANNUAL FLOWERS (SPRING)

Resistant

Floss flower (Ageratum houstonianum)
Summercypress (Kochia scoparia)
Sweet scabious (Scabiosa atropurpurea)

@Susceptible

Arctotis (Arctotis grandis)
China aster (Callistephus chinensis)
Moonflower (Calonyction aculeatum)
Feather cockscomb (Celosia argentea)
Spiderflower (Cleome spinosa)
Cosmos (Cosmos bipinnatus)
Golden cosmos (Cosmos sulphureus)
Globeamaranth (Gomphrena globosa)
Sunflower (Helianthus annuus)
Balsam (Impatiens balsamina)
Sultan snapweed (Impatiens sultani)
Four o'clock (Mirabilis jalapa)
Portulaca (Portulaca grandiflora)
Cypressvine starglory (Quamoclit pinnata)
Castorbean (Ricinus communis)
Scarlet sage (Salvia splendens)
Aztec marigold (Tagetes erecta)
French marigold (Tagetes patula)
Blackeyed clockvine (Thunbergia alata)
Blue torenia (Torenia fournieri)
Verbena (Verbena hybrida)
Periwinkle (Locknera rosea)

Highly Susceptible

Morningglory (Ipomoea purpurea)
Petunia (Petunia hybrida)
Zinnia (Zinnia elegans)

ANNUAL FLOWERS (FALL)

Resistant

Bugloss (Anchusa capensis)
Mexican poppy (Argemone mexicana)
Swanriver daisy (Brachycome iberidifolia)
Clarkia (Clarkia elegans)
Gaillardia (Gaillardia pulchella var. picta)
Lupine (Lupinus pubescens)
Forget-me-not (Mysotis sylvatica)
Baby-blue-eyes (Nemophila menziesii)
Evening primrose (Oenothera speciosa
Pincushionflower (Scabiosa atropurpurea)

Susceptible

Browallia (Browallia speciosa)
Cornflower (Centaurea cyanus)
Sweet sultan (Centaurea moschata)
Leptosyne (Coreopsis stillmani)
Calliopsis Coreopsis tenctoria)
Rocket larkspur (Delphinium ajacis)
Pinks (Dianthus plumarius)
Winter marigold (Dimorphotheca aurantiaca)
California poppy (Eschscholtzia
Sweet alyssum (Lolularia maritima)
Annual stock (Mathiola incana var. annua)
Virginia stock (Mathiola maritima)
Flowering tobacco (Nicotiana alata + var. grandiflora)
Shirley poppy (Papaver rhoeas)
Annual phylox (Phylox drummondi)
Mignonette (Resedra odorata)
Butterflyflower (Schizanthus

california) | pinnatus)
Godetia (Godetia amoena) | Blue laceflower (Trachymene coerulea)
Babysbreath (Gypsophila paniculata) | Nasturtium (Tropaeolum majus)
Strawflower (Helichrysum bracteatum) | Pansy (Viola tricolor)
Rocket candytuft (Iberis amara) | Verbena (Verbena hybrida)
Toadflax (Linaria bipartita) | Sweetpea (Lathyrus odoratus)

Highly Susceptible

Snapdragon (Antirrhinum majus) | Petunia (Petunia hybrida)
Calendula (Calendula officionalis)

FLOWERING PERRENIALS

Resistant

Rudbeckia (Echinacea purpurea) | Globeflower (Trollius ledebouri)
Gaillardia (Gaillardia grandiflora)

Susceptible
Coreopsis (Coreopsis grandilflora) | Salvia (Salvia azurea, Salvia farinacea)
Day lily (Hemerocallis species) | Tritoma (Kniphofia uvaria)
Iris (Iris species)
Phylox (Phylox paniculata, Phylox subulata)

Highly Susceptible

Hollyhock (Althea rosea) | Shasta daisy (Chrysanthemum maximum)

GROUND COVERS AND VINES

Resistant

Cast iron plant (Aspidistra species) | Fatshedra (Fatshedra lizei)
English ivy (Hedera helix) | Yellow jasmine (Gelsemium sempervirens)
Dwarf junipers (Juniperus procumbens) | Coral honeysuckle (Lonicera sempervirens
Liriope (Liriope muscari) | Moonseed vine (Menispermum species)
Plumbago (Plumbago capensis) | Virginia creeper (Parthenocissus quinquefolia)
Strawberry begonia (Saxifraga decipiens | Evergreen smilax (Smilax lanceloata)
Confederate jasmine (Trachelospermum jasminoides) | Coral vine (Antigonon leptopus)
Trumpet creeper (Campsis radicans)

Susceptible

Ajuga (Ajuga repens) | Autumn clematis (Celmatis paniculata)
Creeping euonymus (Euonymus fortunei | Potato vine (Dios corea species)
Trailing lantana (Lantana sellowiana | Hyacinth bean (Dolichos lablab)
Climbing fig (Ficus pumila)
Cypress vine (Quamoclit pinnata

Moss phylox (Phylox subulata)
Dusty miller (Senecio cineraria)
Periwinkle (Vinca major)
Wisteria (Wisteria sinensis)
Verbena (various species)

MEDIUM TO LARGE SHRUBS

Resistant

Bamboo (Bambusa species)
French mulberry (Callicarpa americana
Pampa grass (Cortarderai selloana
Russian Olive (Elaeagnus angustifolia
Chinese elaeagnus (Elaeagnus pungens
Pfitzer's juniper (Juniperus chinensis pfitzerania
Common juniper (Juniper communis)
Texas sage (Leucophyllum Texanum)
Wax myrtle (Myrica cerifera)
Mock orange (Philadephus coronarius
Photinia (Photinia glabra: Photinia serrulata)
Japanese yew (Podocarpus macrophylla maki)
Cherry laurel (Prunus caroliniana)
Indiana azalea (Rhododendron mucronatum)
Yucca, Spanish dagger (Yucca species)
Blue vase juniper (Juniper chinensis blue vase)

Susceptible

Barbery (Bereberis thunbergi)
Sananqua (Camellia sasanqua)
Japanese quince (Chaenomeles lagenaria)
Euonymus (Euonymus japonicus)
Althea (Rose of Sharon) (Hibiscus syriacus
Hydrangea (Hydrangea macrophyllia
Chinese holly (Ilex cornuta Bufordi)
Jasmine (Jasmium primulinum)
Ligustrum (Ligustrum japonicum)
Nandina (Nandina domestica)
Oleander (Nerium oleander)
Pittosporium (Pittosporium tobira)
Flowering pomegranate (Punica grandatum
Fire thorn (Pyracantha unnamemisis)
Mescal bean (Sophora secundiflora)
Popcorn or bridal wreath (Spireae prunifolia plena)
Reeve's spireae (Spireae reevesiana)
Babybreath (Spireae thunbergi)
Viburnum (Viburnum odorathissimum; Viburnum suspensum; Viburnum tinus)

Highly Susceptible

Abelia (Abelia grandiflora)
Cape jasmine (Gardenia jasminoides

SMALL TREES

Resistant

Japanese red maple (Acer palmatum atropurpureum
Red buckeye (Aesculus pavia)
Mimosa (Albizzia julibrissin)
Redbud (Cercis canadensis)
Fringe tree (Chionanthus virginicus)
Chinese parasol tree (Firmiana simplex)
Golden rain tree (Koelreutoria paniculata)
Crape myrtle (Lagestroemia indica)
Wax myrtle (Myrica cerifera)
Parkinsonia or Jerusalem thorn (Parkinsonia aculeata)
Silver maple - White poplar (Populus alba)
Lombardy poplar (Poplar nigra

Moraine honeylocust (*Gleditsia triacanthos moraine*
American holly (*Ilex opaca*)
Yaupon (*Ilex vomitoria*)
Dahoon or cassine holly (*Ilex cassine*)
Deciduous holly (*Ilex decidua*)

italica)
Cherry laurel (*Prunus caroliniana*)
Chinese tallow (*Sapium sebiferum*)
Sassafras (*Sassafras varifolium*)
Vitex or chase tree (*Vitex agnuscastus*)

Susceptible

Loquat (*Eriobotryta japonica*)

Japanese magnolia (*Magnolia* species)

Highly Susceptible

Fruitless mulberry (*Morus alba*)

A listing of ornamentals and their resistance to Cotton Root Rot are found in the Cotton Root Rot Section.

[Blank Page in Original Bulletin]

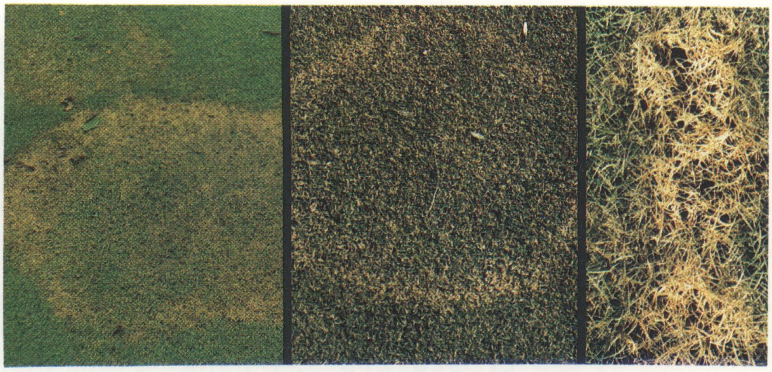
TURFGRASS DISEASES I

1. Helminthosporium melting-out and leaf spot

2. Stripe Smut

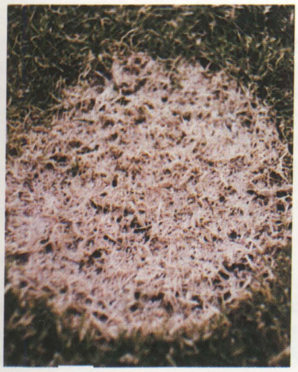
3. Rust

4. Sclerotinia dollar spot

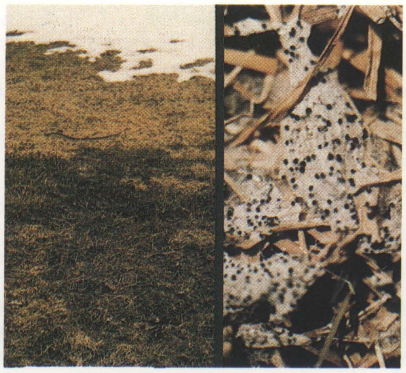


5. Rhizoctonia brown patch, yellow patch, and seedling blight

6. Fusarium blight



7. Fusarium patch



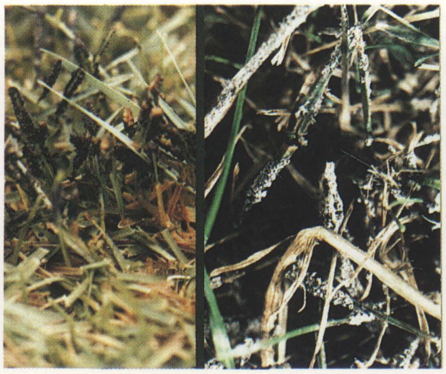
8. Typhula blight

9. Pythium blight

10. Powdery mildew

11. Fairy rings

12. Red thread and pink patch



13. Slime molds

14. Dog injury

TURFGRASS DISEASES I

1. **Helminthosporium Melting-out and Leaf Spot** diseases are caused by a dozen or more species of the fungus *Helminthosporium*. Dark brown, reddish brown to purplish black or olive-green spots form in leaves and sheaths. The leaf lesions enlarge and develop white-gray or tan centers with a dark margin. Girdled leaves die and drop off. The turf thins and develops a yellow or brownish cast. Irregular areas may die when the stem and root tissues decay. These diseases are favored by alternating dry and wet periods, close mowing, low or excessive nitrogen fertilization, a thick thatch, frequent light sprinklings, and growing susceptible cultivars.

2. **Stripe Smut** is caused by the fungus *Ustilago striiformis*. Pale green plants develop long gray streaks that rupture to release masses of black spores. Infected leaves later twist, shred, and die. Patches of smutted plants die during summer droughts. Smut is favored by excess thatch, frequent irrigations, and growing susceptible cultivars.

3. **Rust** diseases are caused by about a dozen species of the fungus *Puccinia*. Yellow, orange or reddish brown, dusty pustules form in leaves and sheaths of grass that is growing very slowly. Heavily rusted grass appears yellow, thin, weak, and is more susceptible to drought, weed invasion, winter-kill, and other damage.

4. **Sclerotinia Dollar Spot** is caused by the fungus *Sclerotinia homoeocarpa*. Roundish, straw-colored spots, up to 2½ inches across, appear on closely cut bentgrass. On lawn-type turf, the spots are 3 to 8 inches in diameter. If unchecked, large, irregular, sunken areas may develop. Tan lesions with a reddish-brown border form on leaves at the margins of affected patches. A white mold grows over leaves in moisture-saturated air. Dollar spot is favored by excess thatch and very low levels of nitrogren and potassium fertilization.

5. **Rhizoctonia Brown Patch, Yellow Patch, and Seedling Blight** is caused by several species of the fungus *Rhizoctonia*. Roughly circular, light brown patches of thinned grass, up to 2 or 3 feet across, appear in hot, wet weather on closely cut bentgrass. A grayish black ring of blighted grass may border the margin. On most other turfgrasses the roundish patches are up to 2 feet across. The turf is thinned or killed when the crowns and roots decay. Yellow patch appears in cool-to-cold weather as yellow, tan, or straw-colored rings, up to 2 feet across, with "healthy" grass in the center. *Rhizoctonia* and other fungi often cause seedling blight in patches. Seedlings may wilt, collapse, and die (damp-off), resulting in bare areas or thin turf. These diseases are favored by poorly drained soils, excessive moisture, nitrogen fertilization and shade.

6. **Fusarium Blight** is incited by *Fusarium roseum*, *F. tricinctum* and several stress factors. Straw-colored circles, crescents, or streaks, up to about 2 feet across, usually with healthy grass in the center, attack Kentucky bluegrass during hot, humid, droughty weather. The disease is favored by a thick thatch, close mowing, lack of water, nematode damage to the roots, a heavy compacted soil, excessive nitrogen fertilization in hot weather, and growing susceptible cultivars.

7. **Fusarium Patch** (Pink Snow Mold), caused by the fungus *Fusarium nivale (Gerlachia nivalis)*, usually appears at the edge of melting snow. Round, bleached-tan to whitish gray or reddish brown spots, up to about 8 to 12 inches across, may merge to kill large irregular areas. A dense, white to pale pink mold covers the margin in wet weather. The mold disappears as the grass blades dry. Fusarium patch is favored by excessive shade, poor air circulation, a thick thatch, and a deep snow cover or abundant moisture for prolonged periods.

8. **Typhula Blight** (Gray Snow Mold), caused by several species of the fungus *Typhula*, occurs at the edge of melting snow. Roundish, grayish white to straw-colored areas, up to about 2 feet across, may merge to form large, irregular areas. The wet grass is briefly covered with a white-gray mold that may appear as a silvery, membraneous crust. Numerous, minute, yellow then dark brown sclerotia form on the grass leaves and crowns. Typhula blight is favored by the same conditions as Fusarium patch.

9. **Pythium Blight** (Grease Spot, Spot Blight and Cottony Blight), caused by several species of the fungus *Pythium*, is active during very wet weather in spring, summer and fall. Roundish, dark, "greasy" to slimy patches of matted grass, up to 6 to 12 inches across, suddenly appear. The patches fade from reddish brown to light brown as the grass dries. Pythium blight may appear in golf greens as streaks that follow water drainage or mowing patterns. White to straw-colored spots **without** a reddish brown border form in the grass blades causing them to twist, collapse, and die. A whitish, cobwebby mold may cover blighted grass in moisture-saturated air. Pythium blight is favored by excessive thatch or shade, lush dense grass, abundant moisture, poor air circulation, and a heavy compacted soil.

10. **Powdery Mildew** is caused by the fungus *Erysiphe graminis*. Superficial, white to grayish patches of mold develop on leaves and sheaths. The turf appears dull white (as if dusted with flour), thin, and weak. The leaves may later turn yellow, wither, and die. Mildew is most serious on Kentucky bluegrass growing in moderate to dense shade.

11. **Fairy Rings** are caused by a number of soil-borne fungi. Circles, arcs, or crescents of dark green, fast-growing grass, often with a ring of thin, wilting, or dead turf inside or outside, form in turf. Most rings are up to 15 feet in diameter with some being 50 feet or more across. Mushrooms (toadstools) or puffballs appear in the outer ring of dark green grass of some rings following heavy rains or watering. Fairy rings are favored by buried organic matter and a thick thatch.

12. **Red Thread and Pink Patch** are caused by several fungi that infect turfgrasses during prolonged, cool-to-warm weather in very humid areas. Round to irregular, light tan to pinkish patches develop that are 2 to 12 inches across. The spots may merge to form large, irregular, bleached-tan or yellowish areas with a reddish brown cast. Bright coral-pink to blood-red "threads," up to ¼ inch or longer, commonly protrude from the leaf tips and sheaths. The threads are gelatinous at first but later dry and become brittle. This disease is favored by slow-growing, nitrogen- and calcium-deficient turfgrass, excessive thatch, lack of water, and weakening by other stresses.

13. **Slime Molds**, caused by several soil-borne fungi, suddenly appear on grass, other low-lying vegetation or objects during wet weather or following deep watering. The slimy masses, up to about a foot across, are watery-white, gray, cream, or black. They soon dry to form bluish, bluish gray, grayish white, black, creamy yellow, orange, or purple-brown spore masses that are easily wiped off leaving the blades beneath a healthy green or somewhat yellow. Slime molds are favored by dense, lush, well-watered grass and excessive thatch.

14. **Dog Injury** is seen as roundish, straw-colored or brown areas, up to 2 feet across, usually bordered by a ring of darker green grass.

For chemical and cultural control suggestions, a listing of resistant turfgrass cultivars and other information, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.

Photo credits: D. H. Scott (1L, 5C, 12), Purdue University (1R, 3R, 4R), University of Illinois (2L, 4C, 5L, 5R, 6, 7, 8, 9, 13R, 14), W. A. Meyer (2R), C. T. Schiller (3L), T. M. Sjulin (4L, 10), T. H. Bowyer (11), and Noel Jackson (13L).

GOLF COURSE

Improved Bermudagrass
Cynodon dactylon

Leaf Blight (fungal - Bipolaris cynodontis, Drechslera gigantea, Bipolaris stenospila): Small, brown-to-purple lesions occur on the leaf blades. Leaf spots are usually more numerous near the collar area of the leaf blade, possibly because of accumulation in this area of spores washed from other portions of the leaf. Severely affected leaves will turn reddish-brown then wither and die. In the early stages, a severely affected turf area may have an overall purple cast. As the disease progresses, the grass gradually thins and the condition becomes advanced before a disease is suspected and verified by the presence of leaf spots. Under severe disease conditions, a sheath and crown rot may be evident and the grass killed in patches.

Smut (fungus - Ustilago cynodonis): Smut galls replace the seed in the spike. The inflorescence is often distorted. The fungus is systemic within the plant, therefore, conventional fungicides will not control the disease. Control through the prevention of seed head development by close mowing and keeping the grass in a vegetative growing condition.

Cottony Blight, Greasy Spot (fungus - Pythium aphanidermatum): Grass is rapidly killed. Affected spots may be several inches in diameter. In the early stages, affected grass appears dark and water-soaked. It will later collapse and appear to be matted together. When the disease is very active, mycelium of the pathogen grows profusely over affected plants so that diseased areas have a cotton-like appearance. The hybrid bermudas are frequently more susceptible to this disease than common bermudagrass. The disease is more prevalent during rainy, foggy weather and in low lying areas of golf courses where air circulation is poor.

Spring Dead Spot (cause unknown): When bermudagrass begins regrowth in the early spring, well-defined circular dead spots become evident. Individual spots may vary in size from a few inches to three to four feet in diameter. The margins of the affected areas are usually even, but may become irregular when individual spots coalesce to form large areas of dead grass several feet in diameter. The foliage of the dead grass assumes a bleached straw color, while the stolons and roots are characterized by a black rot. Spring Dead Spot seems to be a crown, root and stolon rot of dormant grass.

Fading Out (fungus - Curvularia sp.): Fading Out is a serious disease of bermudagrass, particularly on fairways. This condition develops more rapidly during the summer and when grass is stressed because of drought conditions and low fertility. Large dead areas will appear in the turf.

Fairy Rings (fungi - Agaricus sp., Marasmius oreades): There are many soil inhabiting fungi responsible for Fairy Ring on golf courses. Fairy Ring first appears as arcs of circles of dark green, stimulated grass surrounded by areas of light green or dead grass. There are frequently several distinct rings in the same area. Mushrooms or toadstools develop in the band of stimulated grass during rainy periods of spring and fall or following heavy irrigation. The band of green grass sometimes four to five inches wide, is due to increased nitrogen made available to the grass as the fungus breaks down organic matter in the soil. The dead grass is associated with depletion of soil water, since the soil is rendered impervious to water by the great network of fungal mycelium. Fairy Ring is quite often associated with high amounts of organic matter. Dethatching or verticutting greens and fairways will help reduce the incidence of Fairy Ring.

Nematode (nematode - many species): Symptoms often occur as areas of low fertility, even where fertilizers have been applied. This occurs when nematodes feeding on roots reduce their ability to absorb water and nutrients. Nematode damage often may be more severe on greens and tee boxes because of the higher amount of organic matter and more sandy loam type soil.

Slime Mold (fungus *Physarum* sp. and *Fuligo* sp.): A dark gray-to-black crust-like material will form on the leaves and stems of bermudagrass. The soot-type material rubs off easily on shoes and clothing. Slime Mold derives its nourishment from decaying organic matter splashed upon the leaves and stems rather than from the grass. The s ime mold does not feed on the green grass and causes no damage other than shading. It can be removed from the grass by applying water under pressure with a water hose or by brushing with a broom.

Fusarium Blight (fungus - *Fusarium* sp.): Diseased areas are first light green, then fade rapidly to a straw color. Such areas vary from a few inches to more than two feet in diameter and may be circular, crescent-shaped, or streaked. The patch of green grass can often be seen in the central portion of the circular area, creating a frog's eye effect. Lesions on individual blades are irregular in outline and often extend the full width of the blade. They may extend from the cut tip toward the base. Plants are killed when crown tissues are invaded and extensive damage occurs when diseased grass areas are numerous and run together. Using a sound cultural practice that will keep the grass growing vigorously will help control Fusarium Blight.

COMMON BERMUDAGRASS

Cynodon dactylon

Brown Patch (fungus - Rhizoctonia solani): This disease occurs in the late spring or early fall. It is characterized by circular patterns of dead grass blades in the turf. These range from 1-50 feet in diameter. Blades and sheather are pulled easily from stolons because of deterioration in the attachment area. Stolons often remain green. In 2-3 weeks, new leaves may emerge in the center of the circular patch giving the diseased areas a doughnut-shaped appearance. The entire spot eventually may become green during a long growing season. Disease development occurs most rapidly in temperatures between 75^{o}-85^{o}F when free moisture is present. Fungal activity stops when the air temperature reaches 90^{o}F. This explains seasonal development. Some lawns are affected almost every year, while others are damaged only occasionally. Fungicide application should be made when brown patch is expected. On lawns where brown patch occurs occasionally, apply fungicide when the disease first appears.

"Helminthosporium" Leaf Spot (fungus - Bipolaris sp., Drechslera sp.): Symptoms of this fungal disease appear as irregular patches ranging in size from two to several feet in diameter. Infections on leaves appear as small, olive green spots which enlarge to form dark blotches. Infected leaves die and fade to a light tan color. The entire plant is killed when the root rot phase of this disease develops. The disease-causing fungus overwinters in thatch at the base of the plant and acts as a pathogen when weather conditions favor its development during the growing season. Chemical fungicides are effective in control.

Dollar Spot - Small Brown Patch (fungus - Sclerotinia homeocarpa): The disease appears as round, brown or bleached spots the size of a silver dollar or slightly larger. Lesions may be seen on the edges of leaf blades. These cause death of leaf tips. During disease activity, fungal growth appearing like fine cobweb growth, may be present on leaf blades in early morning dew. This disease can occur any time during the year, but it is most prevalent in the late spring or early fall along with the hot, humid days and cool nights. Improved bermudagrass, zoysiagrass and bahiagrass are more susceptible. Adequate nitrogen and spraying with a turf fungicide is recommended to control the disease.

Pythium Blight (fungus - Pythium aphanidermatum): Affects improved bermudagrass. Infected grass rapidly dies in spots or streaks. In early stages of infection, the affected spots may have a "cottony" appearance due to the abundant fungal growth. The disease occurs in poorly drained areas during warm, humid weather. Fungicides are effective for control.

Fairy Rings (fungi - Marasmius sp., Agaricus sp., Chlorophyllum molybdites): Mushrooms in a circle or semi-circle are called "fairy rings". Mushrooms are fruiting structures of fungi produced when weather conditions are favorable. Mushroom-producing fungi develop on organic matter in the soil and produce fruiting structures on the outer limits of the colony, causing a circular effect. Grass is often greener in the ring areas because of available nutrients liberated by decomposition of the fungus. Grass in the center of the ring may be declining because of fungal activity. Warm, wet weather enhances this disease. Control often is not necessary because of the condition's temporary nature. In other cases, however, the affected grass may decline rapidly if corrective steps are not taken. Aerate the soil by punching holes 6-8 inches deep at regular intervals and apply a fungicide drench at the strongest labeled rate.

Smut (fungus - Ustilago cynodontis): Occurs on both St. Augustinegrass and bermudagrass. Smut galls replace the seed in the spike. The inflorescence is often distorted. The fungus is systemic within the plant, therefore, conventional fungicides will not control the disease. Control through the prevention of seed head development by close mowing and keeping the grass in a vegetative growing condition.

Rust (fungus - Puccinia cynodontis): Plants affected with rust have a chlorotic appearance, and stands may begin to thin. Orange-colored linear pustules or raised bumps are evident on leaf blades. These vary in appearance, depending on the species involved. Pustules are difficult to see on affected St. Augustinegrass unless the blades are examined with a hand lens. Zoysiagrass is affected more than either St. Augustine or bermudagrass. Rust is most damaging during mild, warm weather. Rust diseases can be controlled by using fungicides.

Nematode (nematodes - many species): Symptoms often appear as areas of low fertility, even where fertilizers have been applied. This occurs when nematodes feeding on roots reduce their ability to absorb water and nutrients. Where nematodes constitute the limiting growth factor, a nematicide application usually is needed yearly. Good cultural and fertilization practices may help mask nematode injury.

BENTGRASS

Agrostis sp.

Helminthosporium Leaf Spot (fungus - *Bipolaris* sp. and *Drechslera* sp.): This is a warm, wet weather disease usually first seen in late spring. Disease severity increases with the advent of warmer weather usually reaching its peak in late July and August. This leaf blighting disease looks very much like "drought stricken" grass.

Cottony Blight (fungus - *Pythium* sp.): See BERMUDAGRASS DISEASES for description.

Nematode (nematodes - several species): See BERMUDAGRASS DISEASES for description.

RYEGRASS

Lolium sp.

Rust (fungus - Puccinia sp.): Affected ryegrass appears unthrifty and to thin. In severe cases, the grass turns chlorotic as if suffering from a nutrient deficiency. If diseased grass is examined closely, orange-colored, linear pustules, 1-2 mm in length will be evident on the leaf blades. Under ideal disease conditions, pustules may be so numerous that the entire planting may have an orange cast. Ryegrass is more severely damaged by rust than St. Augustinegrass or Bermudagrass.

Seedling Disease (fungi - Pythium sp. and Rhizoctonia sp.): Seedling blight kills the young plants either before or just after emergence, resulting in a reduced stand. Post-emergence attacks cause the seedlings to collapse and die soon after emergence. Seedling diseases are especially damaging during periods of adverse conditions, such as cool, wet weather. Improper planting such as covering the seed too deeply, also increases seedling blight.

Leaf Blight (fungus - Curvularia sp. Bipolaris sp., and Drechslera sp.): Grass generally declines and becomes thin and unsightly. Leaves begin to dry, turn brown, and become crisp. Occasionally, brown-to-purple oblong spots are present on the leaf sheath and blades. Young spots are uniformly colored but tend to develop a tan center as the disease develops.

Powdery Mildew (fungus - Erysiphe sp.): Powdery mildew is especially common on annual grasses that are used for overseeding. It is recognized by the grayish-white fungal growth on the leaves. The white fungal growth can be observed on the upper surface of the leaves and leaf sheaths. As the disease progresses, the leaf turns yellow and is gradually killed.

CENTIPEDE AND ZOYSIAGRASS

Eremochloa ophivroides and Zoysia japonica

Brown Patch (fungus - Rhizoctonia solani): This disease occurs in the late spring or early fall. This disease is characterized by circular patterns of dead grass blades in the turf. These range from 1-50 feet in diameter. Blades and sheather are pulled easily from stolons because of deterioration in the attachment area. Stolons often remain green. In 2-3 weeks, new leaves may emerge in the center of the circular patch giving the diseased areas a doughnut-shaped appearance. The entire spot eventually may become green during a long growing season. Disease development occurs most rapidly in temperatures between 75°-85°F when free moisture is present. Fungal activity stops when the air temperature reaches 90°F. This explains seasonal development. Some lawns are affected almost every year, while others are damaged only occasionally. Fungicide application should be made when brown patch is expected. On lawns where brown patch occurs occasionally, apply fungicide when the disease first appears.

"Helminthosporium" Leaf Spot (fungus - Bipolaris sp., Drechslera sp.): Symptoms of this fungal disease appear as irregular patches ranging in size from two to several feet in diameter. Infections on leaves appear as small, olive green spots which enlarge to form dark blotches. Infected leaves die and fade to a light tan color. The entire plant is killed when the root rot phase of this disease develops. The disease-causing fungus overwinters in thatch at the base of the plant and acts as a pathogen when weather conditions favor its development during the growing season. Chemical fungicides are effective in control.

Fading-out (fungi - Curvularia sp.): Fading-out is a serious problem in many lawns where the grass thins and becomes unsightly. This condition develops more rapidly during the summer when large dead areas appear in the turf. Fading-out is most prevalent on grass weakened by other disease-causing organisms, insect pests, nematodes or improper cultural practices. Effective control of fading-out requires several different approaches. The first is to correct cultural conditions that limit plant growth. Mowing at the proper height, fertilizing according to soil test, watering properly and avoiding thatch build-up all contribute to healthy grass that resists development of weak pathogens. Fungicide applications hasten recovery of affected turf; however, they should be used in combination with good cultural practices.

Dollar Spot - Small Brown Patch (fungus - Sclerotinia homeocarpa): The disease appears as round, brown or bleached spots the size of a silver dollar or slightly larger. Lesions may be seen on the edges of leaf blades. These cause death of leaf tips. During disease activity, fungal growth appearing like fine cobweb growth, may be present on leaf blades in early morning dew. This disease can occur any time during the year, but it is most prevalent in the late spring or early fall along with the hot, humid days and cool nights. Improved bermudagrass, zoysiagrass and bahiagrass are more susceptible. Adequate nitrogen and spraying with a turf fungicide is recommended to control the disease.

Fairy Rings (fungi - Marasmius sp., Agaricus sp., Chlorophyllum molybdites): Mushrooms in a circle or semi-circle are called "fairy rings". Mushrooms are fruiting structures of fungi produced when weather conditions are favorable. Mushroom-producing fungi develop on organic matter in the soil and produce fruiting structures on the outer limits of the colony, causing a circular effect. Grass is often greener in the ring areas because of available nutrients liberated by decomposition of the fungus. Grass in the center of the ring may be declining because of fungus activity. Warm, wet weather enhances this disease. Control often is not necessary because of the condition's temporary nature. In other cases, however, the affected grass may decline rapidly if corrective steps are not taken. Aerate the soil by punching holes 6-8 inches deep at regular intervals and apply a fungicide drench at the strongest labeled rate.

Smut (fungus - Ustilago cynodontis): Occurs on both St. Augustinegrass and bermudagrass. Smut galls replace the seed in the spike. The inflorescence is often distorted. The fungus is systemic within the plant, therefore, conventional fungicides will not control the disease. Control through the prevention of seed head development by close mowing and keeping the grass in a vegetative growing condition.

Slime Mold (fungus - Physarum sp. and Fuligo sp.): A dark gray-to-black crust-like material will form on the leaves and stems of bermudagrass. The soot-type material rubs off easily on shoes and clothing. Slime Mold derives its nourishment from decaying organic matter splashed upon the leaves and stems rather than from the grass. The slime mold does not feed on the green grass and causes no damage other than shading. It can be removed from the grass by applying water under pressure with a water hose or by brushing with a broom. No other control measures are necessary.

Rust (fungus - Puccinia cynodontis): Plants affected with rust have a chlorotic appearance, and stands may begin to thin. Orange-colored linear pustules or raised bumps are evident on leaf blades. These vary in appearance, depending on the species involved. Pustules are difficult to see on affected St. Augustinegrass unless the blades are examined with a hand lens. Zoysiagrass is affected more than either St. Augustine or bermudagrass. Rust is most damaging during mild, warm weather. Rust diseases can be controlled by using fungicides.

Nematode (nematodes - many species): Symptoms often appear as areas of low fertility, even where fertilizers have been applied. This occurs when nematodes feeding on roots reduce their ability to absorb water and nutrients. Where nematodes constitute the limiting growth factor, a nematicide application usually is needed yearly. Good cultural and fertilization practices also help overcome nematode injury.

ST. AUGUSTINEGRASS

Stenotaphrum secundatum

Brown Patch (fungus - *Rhizoctonia solani*): This disease occurs in the late spring or early fall. It is characterized by circular patterns of dead grass blades in the turf. These range from 1-50 feet in diameter. Blades and sheather are pulled easily from stolons because of deterioration in the attachment area. Stolons often remain green. In 2-3 weeks, new leaves may emerge in the center of the circular patch giving the diseased areas a doughnut-shaped appearance. The entire spot eventually becomes green during a long growing season. Disease development occurs most rapidly in temperatures between 75^{o}-85^{o}F when free moisture is present. Fungal activity stops when the air temperature reaches 90^{o}F. This explains seasonal development. Some lawns are affected almost every year, while others are damaged only occasionally. Fungicide application should be made when brown patch is expected. On lawns where brown patch occurs occasionally, apply fungicide when the disease first appears.

Gray Leaf Spot (fungus - *Pyricularia grisea*): Gray leaf spot causes irregular brown-to-gray spots on leaf blades of St. Augustinegrass. In areas of heavy disease development, the grass may have a burned or scorched appearance resulting from death or spotting of the leaf blades. The leaf spots are often diamond-shaped. Lesions also occur on stems and spikes of affected plants. This disease develops rapidly with abundant moisture and warm temperatures. It is usually noticed first in shaded areas that remain damp for some time. Control is best accomplished by avoiding excessive nitrogen fertilization. Water during the early part of the day. Most turf fungicides control this disease effectively.

Fading Out (fungi - *Curvularia* sp.): Fading-out is a serious problem in many lawns where the grass thins and becomes unsightly. This condition develops more rapidly during the summer when large dead areas appear in the turf. Fading-out is most prevalent on grass weakened by other disease-causing organisms, insect pests, nematodes or improper cultural practices. Effective control of fading-out requires several different approaches. The first is to correct cultural conditions that limit plant growth. Mowing at the proper height, fertilizing according to soil tests, watering properly and avoiding thatch build-up all contribute to healthy grass that resists development of weak pathogens. Fungicide applications hasten recovery of affected turf. However, they should be used in combination with good cultural practices.

Fairy Rings (fungi - *Marasmius* sp., *Agaricus* sp., *Chlorophyllum molybdites*): Mushrooms in a circle or semi-circle are called "fairy rings". Mushrooms are fruiting structures of fungi produced when weather conditions are favorable. Mushroom-producing fungi develop on organic matter in the soil and produce fruiting structures on the outer limits of the colony, causing a circular effect. Grass is often greener in the ring areas because of available nutrients liberated by decomposition of the fungus. Grass in the center of the ring may be declining because of fungus activity. Warm, wet weather enhances this disease. Control often is not necessary because of the condition's temporary nature. In other cases, however, the affected grass may decline rapidly if corrective steps are not taken. Aerate the soil by punching holes 6-8 inches deep at regular intervals and apply a fungicide drench at the strongest labeled rate.

Smut (fungus - Ustilago attinis): Occurs on both St. Augustinegrass and bermudagrass. Smut galls replace the seed in the spike. The inflorescence is often distorted. The fungus is systemic within the plant, therefore, conventional fungicides will not control the disease. Control through the prevention of seed head development by close mowing and keeping the grass in a vegetative growing condition.

Slime Mold (fungus - Physarum sp. and Fuligo sp.): A dark gray-to-black crust-like material will form on the leaves and stems of bermudagrass. The soot-type material rubs off easily on shoes and clothing. Slime Mold derives its nourishment from decaying organic matter splashed upon the leaves and stems rather than from the grass. The slime mold does not feed on the green grass and causes no damage other than shading. It can be removed from the grass by applying water under pressure with a water hose or by brushing with a broom. No other control measures are necessary.

Rust (fungus - Uromyces tenuicutis): Plants affected with rust have a chlorotic appearance, and stands may begin to thin. Orange-colored linear pustules or raised bumps are evident on leaf blades. These vary in appearance, depending on the species involved. Pustules are difficult to see on affected St. Augustinegrass unless the blades are examined with a hand lens. Zoysiagrass is affected more than either St. Augustine or bermudagrass. Rust is most damaging during mild, warm weather. Rust diseases can be controlled by using fungicides.

Downy Mildew (fungus - Sclerophthora macrospora): Leaf blades exhibit linear white streaks running parallel to the leaf veins. The epidermis over the disease does not appear to adversely affect the grass. The disease is usually more severe in moist shaded areas.

Nematode (nematodes - many species): Symptoms often appear as areas of low fertility, even where fertilizers have been applied. This occurs when nematodes feeding on roots reduce their ability to absorb water and nutrients. Where nematodes constitute the limiting growth factor, a nematicide application usually is needed yearly. Good cultural and fertilization practices also help overcome nematode injury. (See section on Other Diseases-Nematodes for additional information.)

St. Augustine Decline - SAD (virus): In the early infection stages, leaves show a chlorotic mottling. The mottling or mosaic symptom becomes progressively more severe until a chlorotic appearance is observed. In later stages of disease development, the grass is weakened, leaves and stolons begin to die and invading grasses and seeds crowd out the weakened St. Augustinegrass. Infected grass does poorly in shaded areas. Plant a resistant variety - Floratam, Raleigh or Seville. Seville is very susceptible to downy mildew. Floratam is susceptible to cold injury and should not be used in more northern areas. Raleigh is adapted to the same areas as common St. Augustinegrass.

PHYSIOLOGICAL PROBLEMS OF TURF

Soil Compaction - Certain soils are compacted easily, especially in areas of heavy foot traffic. This condition prevents adequate gas exchange, penetration of moisture and nutrients and restricts root system growth. Several types of aerifiers correct this condition.

Dog Urine Injury - Circular spots 8-10 inches in diameter may appear in areas frequented by female dogs. Heavy watering helps dilute the salt concentration and corrects this condition.

Fertilizer Burn - Commercial fertilizers are salts and can burn grass when applied excessively. This condition is most often seen where fertilizers are spilled.

Excessive Shading - Most lawn grasses require rather high light intensities. When a lawn is fertilized, this in turn stimulates growth of shrubs and tress that shade the grass. Selective pruning of trees and shrubs helps correct this condition.

Sun Scald - Clipping grass too closely removes foliage necessary for food manufacturing and exposes stolons to direct sun rays. When this occurs, a brown lesion or burned areas is found on the upper surface of the stolon. Avoid mowing too closely.

Improper Fertilization - Excessive use of an individual element, such as nitrogen, makes plants more susceptible to disease attack. Avoid this problem by fertilizing according to soil test recommendations.

Shock - Allowing grass to become too tall before mowing causes grass to experience shock and lose vigor. Mow frequently to prevent this condition.

Permanent Wilt - Grass allowed to become too dry may pass the permanent wilt stage where recovery is not possible. This may occur where water does not penetrate because of compaction.

Consult the Chemical Control Supplement (B-1140A) for specific chemical control suggestions.

[Blank Page in Original Bulletin]

TREE DISEASES II


1. Hawthorn rust

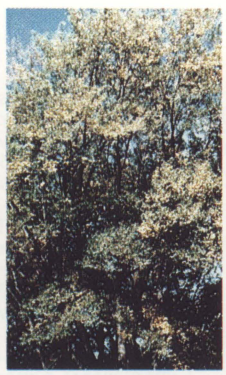

2. Quince rust


3. Cedar-apple rust


4. Juniper rust


5. White pine blister rust

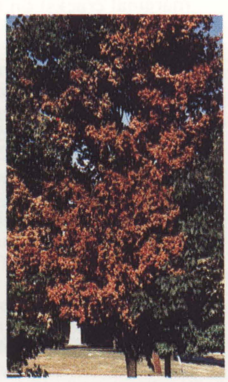

6. Eastern gall rust of pine

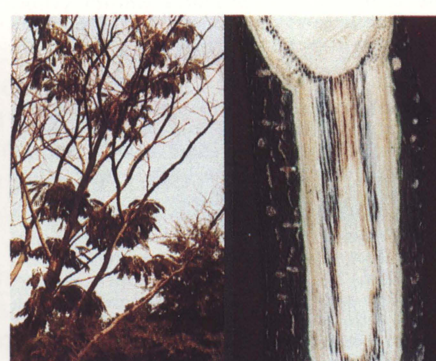

7. Phloem necrosis of elm


8. Dutch elm disease


9. Wetwood of elm


10. Oak wilt


11. Verticillium wilt of maple


12. Mimosa wilt


13. Fire blight of hawthorn


14. Willow black canker


15. Phomopsis canker of Russian olive


16. Bleeding necrosis of sweet gum


17. Sunscald and black rot of mountain-ash

TREE DISEASES II

1. **Hawthorn Rust** is caused by the fungus *Gymnosporangium globosum*. Yellow to orange spots form on the upper leaf surface while raised, orange to brownish spots containing tubelike appendages develop on the corresponding under surface. Other pomaceous hosts include apple and crabapple, mountain-ash, and pear. Alternate hosts of the fungus are species of juniper (see No. 4 below). The fungus overwinters in small brownish galls on juniper.

2. **Quince Rust** is caused by the fungus *Gymnosporangium clavipes*. Hawthorn twigs and fruit are swollen, distorted, and covered with whitish orange, tubelike appendages filled with masses of orange spores. Other pomaceous hosts include apple and crabapple, Japanese quince, mountain-ash, pear, and quince. The fungus overseasons on species of juniper (see No. 4 below).

3. **Cedar-Apple Rust**, caused by the fungus *Gymnosporangium juniperi-virginianae*, infects numerous junipers. Apple and crabapple are alternate hosts. Juniper twigs are stimulated to form small, greenish brown, globular galls. The slowly enlarging galls, by the second spring after infection, are up to 2 inches in diameter. Older galls (or "cedar apples") are chocolate-brown, globular to kidney-shaped, and corky. Small, pitlike depressions form on the gall surface. Orange, gelatinous, fingerlike spore-horns (up to 100 per gall) protrude up to 2 inches from the circular depressions during spring rains. During dry periods the spore-horns wither into wrinkled threads. The galls later dry, shrivel and turn black.

4. **Juniper Rust**. Several juniper species, especially red cedar, are affected by 3 common rusts: cedar-apple, cedar-hawthorn, and cedar-quince. Quince rust appears as slight swellings, somewhat spindle-shaped, on twigs, branches and trunk. The fungus is perennial in the outer living bark. Hawthorn rust (1) galls are similar to those of apple rust (3), but are seldom over ½ inch and produce only a few gelatinous spore-horns. Cedar-hawthorn and cedar-apple rust galls produce spore-horns for only one season.

5. **White Pine Blister Rust**, caused by the fungus *Cronartium ribicola*, attacks 5-needle pines. The fungus invades and kills the needles before growing into twigs and branches. Swollen, oval, yellowish cankers slowly enlarge, girdle, and kill stems. Killing of pines progresses from small to larger branches and into the trunk. Several years after the needles were infected, the cankered bark produces whitish yellow blisters filled with masses of orange-yellow spores. The spores are carried by the wind to infect leaves of certain currants and gooseberries, the alternate hosts.

6. **Eastern Gall Rust of Pine**, caused by *Cronartium quercuum*, attacks numerous pines forming roundish galls on the stems. Alternate hosts include oaks and chestnuts. In spring, yellow fruiting bodies, filled with dusty spores, break through the pine bark in a brainlike arrangement. The fungus overeseasons in pine stems.

7. **Phloem Necrosis of Elm**, caused by a mycoplasmalike organism, is widespread and destructive. Elm leaves curl upward at the margins, turn yellow or brown and drop. The disease can be confused with Dutch elm disease (8) and other elm wilts. A reliable symptom is a butterscotch yellow color of the inner bark, often flecked with brown or black when freshly cut, plus a wintergreen odor. Transmission is by the white-banded elm leafhopper (*Scaphoideus luteolus*).

8. **Dutch Elm Disease**, caused by the fungus *Ceratocystis ulmi*, is the most destructive shade tree disease. All American and European elms are susceptible. Leaves on the tips of one or more branches wilt, curl, and turn yellow or brown ("flag"). Many elms show progressive wilting, discoloration, and dropping of leaves on additional branches until the tree dies in several weeks to a year or more. Dark brown or black streaks develop in the sapwood (other wilts show similar streaking). Elm bark beetles (*Scolytus multistriatus* and *Hylurgopinus rufipes*) breed in dead and dying elm wood. The beetles transmit the fungus when they feed in twig crotches of nearby healthy elms. Transmission from diseased to healthy elms also occurs via root grafts.

9. **Wetwood of Elm** is cosmopolitan and caused by a bacterium. Invaded spring wood and heartwood becomes watersoaked and dark brown. Fermented sap under pressure (up to 60 psi) in diseased wood is forced out through cracks, branch crotches and wounds. The dark flux flows down the trunk or branches and dries to a grayish white incrustation. Affected elms often show yellowing, scorching, wilting, and dropping of leaves. Branches may die back and the tree shows a general decline.

10. **Oak Wilt**, caused by the fungus *Ceratocystis fagacearum*, is widespread, serious, and affects all species of oak. Leaves in the crown of red and black oaks turn dull pale green then yellow to bronze or tan (starting at the margins), curl upward, and drop. Symptoms progress downward and inward throughout the tree. Mature leaves are usually stiff before dropping; immature leaves curl, droop, turn dark brown to black, and remain attached. Leaves on wilting bur and white oaks usually turn light brown or straw-colored, curl, and remain attached. Red and black oaks commonly wilt and die in 4 to 6 weeks; white and bur oaks usually die slowly ("staghead") over a period of years. Transmission is from diseased to healthy oaks via root grafts and over longer distances by feeding of sap-feeding insects in fresh wounds.

11. **Verticillium Wilt of Maple**, and 300 other species of woody and nonwoody plants, is caused by the fungus *Verticillium albo-atrum (V. dahliae)*. Maple leaves usually wilt and turn brown suddenly in summer on a few branches, on whole sections, or the entire tree. The sapwood may show greenish streaks. The soil-inhabiting fungus invades through wounds in roots and stems.

12. **Mimosa Wilt** is caused by the fungus *Fusarium oxysporum* f. *peniciosum*. Leaves on certain branches wilt, turn yellow, hang down, die, and drop. Brown to black streaks form in the sapwood. The soil-borne fungus enters through the roots. Nematode feeding may increase the incidence of wilt.

13. **Fire Blight of Hawthorn** is caused by the bacterium *Erwinia amylovora*. Other hosts include apple and crabapple, amelanchier, cotoneaster, mountain-ash, photinia, pyracantha, quinces, and spirea. The blossoms, leaves and twigs suddenly wilt and appear scorched by fire. Affected twigs and small branches die. The bacterium overwinters in living tissue at the edge of discolored, slightly sunken cankers (with marginal cracks) on the branches and trunk.

14. **Willow Black Canker** is caused by the fungus *Physalospora miyabeana*. The fungus proceeds from leaves (which curl and wither) through the petioles into twigs and larger branches where conspicuous, girdling black cankers are formed--followed by defoliation. The fungus produces pinkish spore masses on dead twig and branch cankers.

15. **Phomopsis Canker of Russian Olive**, caused by the fungus *Phomopsis elaeagni*, is common and serious in the Midwest. Oval to elongate, depressed, reddish brown cankers with smooth bark form on the branches and trunk. Cracks often form around the margins. Girdled parts wilt and die. The withered leaves remain attached for some time.

16. **Bleeding Necrosis of Sweet Gum**, caused by the fungus *Botryosphaeria dothidea*, induces profuse bleeding from younger branch and trunk cankers and emits an unpleasant, sweet odor. Bleeding areas are connected internally to reddish brown sapwood. Weakened trees may produce numerous sprouts along the branches. When severe, trees exhibit branch dieback and later a general decline. The disease occurs mainly on stressed trees.

17. **Sunscald and Black Rot of Mountain-ash**. The south side of densely shaded trees, when suddenly exposed to intense sun, often develop summer sunscald (cankers) that kills the bark. The black rot fungus, *Physalospora obtusa*, commonly invades the dead bark. Numerous, raised, black, fungus-fruiting bodies form in the cankers.

For cultural and chemical control suggestions, and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.

Photo credits: D. Neely (1, 16), T. M. Sjulin (2L), Purdue University (2R, 3R, 4, 13), University of Illinois (3L, 8, 10L, 14, 17), BASF (5), University of Georgia (6), Illinois Natural History Survey (7, 15L), P. C. Pecknold (9), D. F. Schoeneweiss (10R, 11, 15R), USDA and Clemson University (12).

ASH

Fraxinus spp.

Anthracnose (fungus - *Gloeosporium* sp.): Large areas of the leaf, especially along the edges and veins, turn brown. Premature defoliation will follow severe anthracnose infection during wet seasons. The disease may be confused with problems caused by weather adversities or other physiological problems. Spraying with a fungicide two or three times at 14 day intervals during humid periods will control the disease.

Leaf Spots

(fungi - *Cylindrosporium* sp., *Marssonina* sp.): Among the most common foliage diseases of ash that occur virtually wherever ash is grown. Lesions appear early, hundreds may develop on a single leaflet. They are very small at first. Spray as recommended for anthracnose to control the disease.

(fungi - *Mycosphaerella fraxinicola*, *Phyllosticta* sp.): Another common leaf spot of ash appears toward the end of summer. Groups of small dark fruiting structures form in spots on the bottom of the leaf, while the upper side may show only a slight spotty discoloration. By the time the spots on the top turn brown, defoliation has begun. Spray as recommended for anthracnose to control the disease.

(fungi - *Cercospora fraxinites*): Spots are irregular to almost circular, three to seven mm in width. The long, thin, many-celled spores are produced on black stromata within the dull gray-brown spots. Spray as recommended for anthracnose.

Rust (fungus - *Puccinia sparganioides*): Swollen and distorted gall-like structures occur on leaves and twigs. The orange swellings are more common early in the growing season, particularly in the Gulf Coast area. Two stages of the rust fungus are known: one which occurs on ash trees, the other on grasses, *Spartina* sp. Spraying with fungicides at two to three week intervals during early spring will control the disease.

Cotton Root Rot (fungus - *Phymatotrichum omnivorum*): Ash is moderately susceptible to the cotton root rot fungus, particularly during the younger stages of growth. (See section on Cotton Root Rot.)

Wood Rots (fungi - *Poria* sp., *Fomes* sp., *Polyporus* sp., etc.): Most of these fungi attack only weakened or wounded trees. Infection usually takes place through wounds caused by lawn mowers, pruning, or strong winds. Trees decline slowly for no apparent reason and the fungus slowly rots the wood. After the disease has progressed for some time, leathery, hard structures (conks) can be seen attached to the lower parts of the trunk. These are fruiting bodies of the fungus appearing as bracket growth during certain times of the year. Control is accomplished by avoiding mechanical wounds, treating exposed wounds with pruning paint, fertilizing trees as needed and protecting from insects.

Powdery Mildew (fungus - *Phyllactinia guttata*): White powdery fungus growth on the leaves during the summer, then forming small black round fruiting structures in the late summer and fall. Damage is usually not extensive enough to warrant control.

<u>Hairy Root</u> (bacterium - <u>Agrobacterium rhizogenes</u>): A large number of very small roots develop either from the base of the stem or the larger roots. No control is known.

<u>Cankers</u> (fungi - <u>Cytospora</u> sp., <u>Diplodia</u> sp., <u>Dothiorella</u> sp., <u>Nectria</u> sp.): Several fungi cause branch and trunk cankers on ash. None of them are very common. Prune out infected branches. Maintain the trees in good condition by fertilizing, watering and spraying for insects.

<u>Nematodes</u> (Root Knot, Dagger, etc.): (See section on Nematodes.)

<u>Leaf Scorch</u> (physiological): (See section on Leaf Scorch.)

BOXELDER

Acer negundo

Verticillium wilt (fungus - Verticillium albo-atrium): This is one of the most common fungal diseases of plants attacking over 300 species. Boxelder is a member of the maple family and this disease is the most important killer of trees in that family. Symptoms include sudden wilting, usually of individual branches, followed by yellowing and finally browning of the foliage. Extensive internal streaking of the outer sapwood. Infected trees should be removed and burned. If a tree is to be saved for as long as possible, prune off all dead and dying branches. Cutting tools should be sterilized with 10 percent bleach between cuts. Inspect the tree periodically for dying branches.

Anthracnose (fungus - Gloeosporium sp.): Spots are indefinite, light brown, and may enlarge and run together causing the death of entire leaves. Leaves partially killed appear as if scorched. The disease is more common during prolonged rain periods when it may cause severe defoliation of trees. Several applications of fungicides may be required to control the disease during periods of high humidity.

Leaf Spot (fungi - Phyllosticta minima, Rhytisma punctatum, Cristulariella pyramidalis): These fungi attack many species of the maple family (Acer) including boxelder. The following fungi attack only boxelder: Phyllosticta negundinis, Cylindrosporium negundinis, Septoria negundinis, and Cercospora negundinis. Many leaf spots, one-fourth inch or more in diameter, some irregular, some with indefinite margins, occur on boxelder. Spots have brown margins and light colored centers. Some of the spots may develop black bodies, which are the fruiting structures of the fungi. Diseased, fallen leaves should be raked up and burned. Spraying the tree several times at two week intervals may be needed to keep the disease in check.

Powdery Mildew (fungus - Uncinula circinata): A white to grayish mold develops on the surface of the leaves. The disease is seldom serious on boxelder.

Heart Rot (fungus - Fomes sp.): The fungus enters the trunk generally through wounds or branch stubs resulting from pruning or mechanical damage. The rot is generally found on dead timber, but the fungus can get established on living trees and destroy the heartwood. New conks, or fruiting bodies of the fungus may appear annually, but they are perennial structures, putting on another spore-producing layer each year. Best control is achieved through prevention. Avoid mechanical injuries to trees, such as would result from hitting the trunk with lawn mowers and other garden instruments. Paint wound with a pruning compound; remove and destroy conks. Make pruning cuts flush with the main trunk and do not leave branch stubs.

Crown Gall (bacterium - Agrobacterium tumefaciens): (See section on Crown Gall.)

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Boxelder is moderately susceptible to the cotton root rot fungus. (See section on

Cotton Root Rot.)

Herbicide damage: Boxelder is highly susceptible to 2-4-D, causing distortion, dwarfing, and blighting of foliage.

CATALPA

Catlapa bignonioides

Verticillium Wilt (fungus - Verticillium albo-atrum): This is the major disease of ornamental catalpas. Trees wilt suddenly, defoliate, and have a brownish discoloration of the outer sapwood. There is no control. Heavy fertilization sometimes enables infected trees to put a new ring of summerwood and springwood outside the infected area, stopping the radial spread of the fungus. Some trees may then recover.

Leaf Spot (fungi - Cercospora sp., Phyllosticta sp.): Round to irregular brown to black spots appear during prolonged periods of damp weather. Center of spots may fall out, leaving a "shot hole" appearance. Collect and burn fallen leaves. Chemical control usually not necessary. Spray valuable trees as leaves unfurl, when half-grown, and again when full grown.

Powdery Mildew (fungus - Microsphaera alni, Phyllactinia corylea): White to gray powdery mold on both leaf surfaces, usually late in the season on younger leaves. Leaves may be deformed or curled. Spray as needed with a powdery mildew control fungicide.

Trunk Rots (fungi - Collybia velutipes, Polyporus versicolor, and Polyporus catalpae): These tree fungi are heartwood rotters of catalpa that enter through wounds. Avoid wounding and keep the tree in good condition by fertilizing and watering.

Rosette: (See section on Pecan Diseases.)

Leaf Scorch: Usually caused by heat or drought.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Catalpa is rated intermediate in susceptibility to Phymatotrichum omnivorum.

Chlorosis: (See section on Chlorosis.)

Crown Gall: (See section on Crown Gall.)

Root Knot Nematode: (See section on Root Knot Nematode.)

Wood Rot: (See section on Wood Rot.)

CEDAR, JUNIPER, ARBORVITAE AND CYPRESS

Cedrus spp., Juniperus sp.,

Thuja occidentalis, and Taxodium spp.

Twig Blights (fungi - Diplodia sp., Phomopsis sp., and Coryneum sp.): Needles, twigs and smaller branches turn light brown to reddish-brown; gradually die back from tips. Sometimes serious on seedlings and young trees in wet seasons. Tiny, brown to black dots appear later on infected parts. Prune and destroy blighted parts. Spray regularly.

Winter Injury (non-pathogenic): Injury evident in late winter and spring. Previous year's foliage is scorched, turns brown and dies back from tips of branches. Water plants during dry winters. Mulch during winter to conserve moisture and prevent freeze damage to roots.

Root Rot (fungus - Phytophthora sp.): Foliage wilts and fades to tan, yellow or light brown. Branches or tops die back. Grow in well-drained areas.

Rust (fungus - Gymnosporangium spp.): Greenish-brown to reddish-brown, corky, round to irregular galls on leaves and small branches. Masses of bright orange to brown, jelly-like spore horns form in wet spring weather. Prune out and destroy all infected areas.

Sooty Mold (fungus - Capnodium sp.): Unsightly, dark brown on black blotches coating the needles and branches. This is a fungus that usually grows on honeydew excretions made by insects (e.g., aphids, scales, white flies and others) or in flowing sap. The only damage caused by the fungus is through shading. Control insects.

Trunk Rot (fungus - Fomes sp.): (See section on Wood Rots.)

Annosus Root Rot (fungus - Heterobasidion annosum): The greatest enemy of Eastern red cedar over much of its range. This fungus completely destroys the living bark and sapwood of the roots to the root collar, but seldom extends into the trunk. The fungus fruiting structures, irregular whitish conks, are found under the duff at the ground line. Most common in East Texas. No practical control.

Crown Gall: See section on Crown Gall.)

Mushroom Root Rot: (See section on Mushroom Root Rot.)

Cotton Root Rot: (See section on Cotton Root Rot.)

COTTONWOOD AND POPLAR

Populus spp.

Cytospora Canker (fungus - Cytospora chrysosperma): Primarily affects weak trees and occurs mainly on stems. Cankers first appear as slightly sunken areas on the smooth bark of branches and trunks. Cankers generally develop in an elliptical pattern and enlarge until stems are girdled and killed. Diseased part becomes discolored and sapwood is reddish-brown and watersoaked. During moist weather, reddish threads of fungus spores ooze from pimple-like fruiting bodies on cankered areas. Infected limbs should be removed, as the fungus moves down the stem and invades larger branches or even the trunk. Tree surgery to remove cankers in the main trunk may prolong the life of the tree. Sterilize pruning tools. Avoid wounding trees. Simon and Lombardy varieties are extremely susceptible - Rio Grande is resistant.

Dothichiza or Branch Canker (fungus - Dothichiza populea): This disease mainly attacks young planted and nursery trees. Dark, sunken, cracked cankers form on twigs, trunks and branches. Callus tissue may form in old cankers. Sapwood is discolored. Wounds are primary source of entry for the fungus and should be avoided. Lombardy is by far the most susceptible species. No effective control measures are known. Pruning of diseased parts does not help control this disease, in fact, it spreads it.

Septoria Canker (fungus - Septoria musiva or Mycosphaerella populorum): Cottonwood and Lombardy varieties are susceptible. Leaf infection precedes twig or stem infection. Canker is not easily distinguished from Cytospora canker. The canker on highly susceptible young stems appears sunken, with smooth bark and raised, irregularly concentric rings of unbroken bark. Some cankers are flat, others are swollen at the margins. Identification usually depends on finding little black fruiting structures (pycnidia). Remove infected limbs. Avoid wounding trees and sterilize pruning tools. Preventative fungicide sprays may control the leafspot stage.

Powdery Mildew (fungus - Uncinula salicis): A white fungus grows on both sides of the leaves. Damage is usually not serious enough to warrant control measures, but fungicides can be used on valuable trees.

Heart Rot (fungus - Fomes spp.): Primarily a disease of heartwood. Discoloration and soft rot of heartwood. Distinguishing feature is the shelf-like fruiting structures or conks formed on the main trunk. Trees with conks may live for several years. Remove only trees that are structurally unsound or completely dead. Avoid wounding healthy trees.

Wet Wood (bacterial): Occurs in Cottonwood and Lombardy Poplar. This disease is caused by a bacterial infection. (See Wet Wood in Elm Disease section for details and control.)

Rust (fungus - Melampsora medusae): Small, yellowish-orange pustules on lower surfaces of leaves. Pustules later turn dark brown or black. Generally, most severe during cool fall weather, but not severe enough to warrant control.

Fungal Leaf Spots (fungi - Cercospora populicola, Septoria spp., Marssonina populi): Irregular to round lesions, from brown to gray in color. Spots may coalesce and cause defoliation with severe infections. The most common leaf spot is caused by Marssonina populi. Large brown spots with darker brown margins cause premature defoliation. Twigs are also invaded and killed. Foliar fungicides should be used on a regular basis.

Crown Gall (bacterium - Agrobacterium tumefaciens): This organism has been reported to cause branch and root galls on cottonwood in Texas.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Cottonwood and Lombardy Poplar are moderately to highly susceptible. (See section on Cotton Root Rot.)

Mistletoe (Phoradendron tomentosum subsp. macrophyllum): (See section on Mistletoe.)

Chlorosis: (See section on Chlorosis).

DOGWOOD

Cornus spp.

Sun Scald: Death within the first two years after transplanting is most commonly due to sun scald, lack of soil moisture or careless transfer of trees too large or without adequate root systems. Transplant small trees into partial shade during December of January. Container grown nursery trees are less subject to mortality. Wrap tree trunk loosely with paper. Water and fertilize properly.

Ascochyta Leaf Blight (fungus - *Ascochyta cornicola*): This fungus produces irregular leafspots varying in size, with gray to tan centers and prominent borders. The leaf may completely collapse, shrivel, and turn black.

Leaf Spot (fungus - *Cercospora* sp.): Spots of various sizes with dark brown to purplish borders and grayish centers. Not normally serious, but chemical control may be desirable if disease reappears annually.

Botrytis Petal Blight (fungus - *Botrytis cinerea*): This fungus disease affects foliage and green shoots as well as petals. This is a disease of wet spring weather that often follows frost damage. Bracts or "petals" rot in irregular brown patches. During very wet weather these rotting bracts are covered with a gray-brown, fuzzy mold that produces powdery spores. Spray early when flower buds start to open.

Cotton Root Rot (fungus - *Phymatotrichum omnivorum*): Dogwood is extremely susceptible to the Cotton Root Rot fungus, but also is not adapted to the root rot areas of Texas.

Crown Gall: (See section on Crown Gall.)

Mushroom Root Rot: (See section on Mushroom Root Rot.)

Wood Rot: (See section on Wood Rot.)

ELM

Ulmus spp.

Black Leaf Spot (fungus - Gnomonia ulmea): Small, yellow spots appear first on upper surface of leaves, then gradually develop a shiny black appearance. Heavy spotting causes leaf yellowing and early defoliation in wet seasons. Usually defoliation does not occur much before normal leaf fall so control is not warranted. If trees have been affected seriously in previous seasons, fungicidal sprays applied when leaves are unfolding, when they reach full size, and again two weeks later will help prevent serious defoliation. Raking and burning fallen leaves will reduce inoculum for future infection.

Other Leaf Spots (fungi - Gloeosporium sp., Cercospora sp., Phyllosticta sp., and others): Dark, elongated spots develop on midribs, veins and margins of leaves, or spots of various shapes and colors may develop on any portion of leaf surface. Destroy fallen leaves and control as for black spot.

Wet wood or Slime Flux (bacterium - Erwinia nimipressuralis): Chronic bleeding of sap from crotches, wound or other weakened areas of trunk, with unsightly discoloration of bark in affected area. Sap frequently is sour smelling. Bleeding or fluxing is most pronounced during spring months or during wet weather. The problem results from fermentation processes of the causal bacteria creating pressures up to 60 pounds per square inch within the tree. Tapping directly into the trunk just below the affected area to provide an outlet for abnormal sap and gasses will relieve internal pressure and may aid in recovery. Drill a small hole (one-half inch diameter or less) directly below the bleeding site and slightly upward into the center of the trunk. Install a tight fitting drainpipe in the drilled hole making sure the end of pipe extends far enough outward so that sap does not fall on the tree.

Dutch Elm Disease (fungus - Ceratocystis ulmi): Symptoms may appear on one or more branches on any part of the tree in contrast to phloem necrosis where tops of infected trees show first abnormalities. Leaves on individual branches wilt and turn yellow; in some instances leaves wilt very rapidly, dry out, then fall while still green. Twig terminals of affected branches sometimes become curved to resemble a shepherd's crook. As a further diagnostic aid, twigs when cut across, show discoloration or browning of water-conducting tissues in the sapwood. Tree defoliation may occur rapidly or take place over an entire season. Likewise infected trees may die in a single season or live for several years. The disease is spread by elm bark beetles infested with the causal fungus. Development of this disease has been limited in Texas.

Elm Leaf Scorch - (bacterium) - A rickettsialike bacterium has been associated with this condition. Vascular bundles are plugged to the point where water movement in the tissues is impaired. No control is known.

Powdery Mildew (fungi - Phyllactinia guttata, Uncinula macrospora, Microsphaera alni): Powdery whitish to gray growth on both sides of leaves. Affected leaves may be cupped, stunted, and show yellowing. The disease usually occurs so late in the growing season that chemical control is not necessary.

Mistletoe (parasitic plant - Phoradendron flavescens): See section on Mistletoe.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): (Chinese Elm is highly susceptible). See section on Cotton Root Rot.

Mushroom Root Rot: (See section on Mushroom Root Rot.)

Verticillium Wilt: (See section on Verticillium Wilt.)

Wood Rot: (See section on Wood Rot.)

Root Knot Nematode: (See section on Root Knot Nematode.)

MAGNOLIA

Magnolia spp.

Leaf Spots (fungi - *Coniothyrium* sp., *Epicoccum* sp., *Glomerella* sp., *Phyllosticta* sp., and *Septoria* sp.): Various sized leaf spots generally developing in late fall and early spring. Generally cause little damage.

Algal Leaf Spot (alga - *Cephaleuros virescens*): Forms a velvety coating with reddish-brown hair-like structures on the underside of the leaves. Occurs mainly in the Gulf Coast area. Causes little damage but treatment with fungicides may be required in some cases.

Leaf-Shedding: Magnolia will begin dropping leaves in November and continue until early spring. This is a natural phenomenon and the degree of leaf drop will depend upon genetic as well as physiological factors affecting the tree. Some trees may be completely denuded before new foliage comes out.

Wood Rots (fungi - *Fomes* sp., *Polyporus* sp., *Daedalea ambiqua*): Rot of heart wood. Colors range from white to black, may also be green or red or brown. Lines of infection are conspicuous. Conks may be formed on main trunk near soil line. Avoid wound. Infected portions may be removed by tree surgery.

Cotton Root Rot: (See section on Cotton Root Rot.)

Root Knot Nematode: (See section on Root Knot Nematode.)

Chlorosis: (See section on Chlorosis.)

Winter Injury: Some trees that harden off gradually in the fall can take temperatures as low as $0^{O}F$ and show no damage. Other individuals are hurt easily if temperatures commonly get below $15^{O}F$. Killing of leaves and shoots can be extensive. Winter drought coupled with low temperatures can cause extensive die back or death.

MAPLE

Acer spp.

Anthracnose (fungus - Gloeosporium apocryptum): In rainy seasons this disease may be serious on silver maples and Japanese maples. Irregular, light to reddish-brown, or purplish-brown, dead areas occur on the leaves. Many spots occur along the veins. Areas often enlarge killing the entire leaf. Leaves partially killed appear as if scorched. Many infected leaves drop in late spring. Twigs may die back. Collect and destroy fallen leaves. Spraying with a recommended fungicide when buds begin to unfold in the spring and again in 10 to 20 days will help prevent infection.

Leaf Scorch (physiological): Light or dark brown areas along the leaf margins extending toward the mid vein. Foliage appears bronzed, dried and scorched. Causes: late spring frost; hot, drying summer winds; and drought. Water trees during summer droughts. Plant in areas protected from drying winter and summer winds.

Wilt (fungus - Verticillium albo-atrum); Sudden wilting and drying of leaves on individual branches, particularly on one side of the tree. New leaves may be reduced in size and turn yellow. Infected trees may die slowly or suddenly. An olive-green discoloration may develop in the sapwood. Other fungi can also cause this discoloration. The disease does not spread rapidly from tree to tree. Infection takes place most commonly through the roots because the fungus lives in soil. Some infections take place above ground through wounds caused by insects or by pruning. Trees showing general wilting of the entire tree cannot be saved. Recently infected trees with only a few wilted branches may possibly be saved by adequate fertilization and watering. It is thought that leaf growth is stimulated, in turn enabling the rapid formation of a thick layer of sapwood, which seals in the infected parts of the trees.

Crown Gall (bacterium - Agrobacterium tumefaciens): Rough, irregular, swollen galls at the base of the trunk or on the roots. (See section on Crown Gall.)

Ganoderma Rot (fungus - Ganoderma lucidum): Rapid decline and death of tree. Large, reddish, and varnish-like mushrooms form at the base of the infected tree. No control known for this type disease.

Powdery Mildew (fungus - Uncinula circinata): White fungus growth on leaves. Rarely serious enough to use control measures.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Silver maple is rated as highly susceptible to Phymatotrichum omnivorum).

Mushroom Root Rot (fungus - Armillaria (Clitocybe) tabescens): (See section on Mushroom Root Rot.)

Trunk Rot (fungus - Fomes sp., Hydnum sp., and Polyporus sp.): Refer to section on Wood Rots and shade trees.

MESQUITE

Prospopis spp.

Powdery Mildew (fungus - Erysiphe taurica): Infected leaves are covered with a white powdery material. When disease is severe, infected leaves can be distorted. Benomyl can be used for the control of this organism, however, control is not generally necessary.

Spongy Yellow Heart Rot (fungus - Fomes everhartii): The fungus enters through broken limbs or through insect tunneling. In advance stages the interior of the tree will be a soft, spongy yellow or brown mass. Perennial cankers are bracket to hoof shaped. The upper surface of the fungus is dark brown to black while the underneath is a dull reddish brown. Control is not recommended.

Rust (fungi - Ravenelia arizonica and Ravenelia holwayii): Rust attacks the leaves causing a distortion of the leaf mid vein. It is most often observed on the first leaves in the spring. Damage is usually not significant and control is not required.

Leaf Spot (fungus - Cercospora prosopidis): Although the fungicide benomyl would control the leafspot, its use is generally not necessary due to the limited damage caused by the fungus.

Crown Gall (bacterium - Agrobacterium tumefaciens): (See section on Crown Gall.)

Cotton Root Rot (fungus - Phymatotrichum omnivorum): See section on Cotton Root Rot.)

MIMOSA

Albizzia julibrissin

Mimosa or Fusarium Wilt (fungus - *Fusarium oxysporum* f. sp. *perniciosum*): The leaves wilt, dry and shrivel, although they may remain green or yellowish for some time. Later the leaves fall and the branch dies. Sometimes only one side of a tree may be affected the first year of onset of symptoms. Suckers may sprout from the main trunk, but there is usually no recovery. Brown discoloration can be found in the sapwood of trunks and branches even before the leaves wilt. Discolored areas of cut stems may appear as complete rings. Dark rings are also present in the roots. Infection is through the roots. The fungus can be carried over in seed from diseased trees. Two wilt-resistant varieties are available - Charlotte, with light-colored flowers, and Tryon, with deeper red flowers.

Leaf Spot (fungus - *Cercospora glauca*): The only described leaf disease of mimosa in this country. Angular, small, dark brown spot develops as disease progresses, the center of the spot may become pale. Disease generally not serious enough to warrant treatment.

Cotton Root Rot: (See section on Cotton Root Rot.)

Root Knot: (See section on Root Knot.)

MULBERRY

Morus spp.

Bacterial Blight (bacterium - Pseudomonas syringae pv. mori): Watersoaked spots appear on leaves and shoots have black stripes. The leaves at the twig tips wilt and dry up. Some control is obtainable on young trees by pruning dead shoots in autumn and spraying with approved fungicides.

Leaf Spots (fungi - Cercospora moricola C. missouriensis, an Cercosporella sp.): The leaves of mulberry are spotted by these fungi in very rainy seasons. The Cercosporella fungus can cause defoliation of older trees. Valuable specimens should be sprayed with approved fungicide if leaf spots are serious.

Popcorn Disease (fungus - Ciboria carunculoides): This disease, known only in the southern states, is largely confined to the carpels of the fruit. It causes them to swell and remain greenish, and interferes with ripening. The disease is of little importance. It does not lessen the value of the tree as an ornamental.

False Mildew (fungus - Mycosphaerella mori): The foliage of mulberries growing in the southern states may suffer severely from attacks of this fungus. It appears in July as whitish, indefinite patches on the undersides of the leaves. Yellowish spores emerge from the stomata on the underside and spread out so as to form a white, cobweb-like coating; the general appearance is that of a powdery mildew. The asexual spores are colorless, each composed of several cells. The infected leaves fall to the ground, and the overwintering or ascocarpic stage matures in spring on these leaves. Gather and burn all fallen leaves in autumn. Spray with approved fungicide mixture as soon as the mold appears in July.

Cankers: Cankers on twigs and branches and die back of twigs may be caused by at least six fungi: Cytospora sp., Dothiorella sp., Gibberella baccata F. moricola, Nectria sp., and Stemphylium sp. These can be distinguished only by microscopic or laboratory tests. Prune and burn dead branches. Keep trees in good vigor by watering and fertilizing.

Powdery Mildews (fungi - Phyllactinia corylea and Uncinula geniculata): The lower leaf surface is covered by a white, powdery coating of these fungi. Valuable specimens can be protected by occasionally spraying with approved fungicide.

Mushroom Root Rot (fungus - Armillaria mellea): Attacks in its usual manner with hardwoods, in that while its rhizomorphs may occur generally on healthy root bark, pathogenic invasion and damage by A. mellea is almost always preceded by major root injury or other debilitation of the host.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): White mulberry has been rated highly susceptible to cotton root rot. The Russian mulberry was tested for planting as a shelterbelt tree in the root rot prone areas of Texas and Oklahoma. Based on six years of records it was considered "intermediate in susceptibility, possibly usable on sandy sites."

Root Knot Nematodes (Meloidogyne sp.): These nematodes attack seedlings in the East and Southwest. The problem can be serious on young trees but has less effect on older trees.

Summer Scorch (physiological): Leaves on affected trees have chlorotic margins. This condition is thought to be caused by low soil moisture and high atmospheric temperatures.

OAK

Quercus spp.

Anthracnose (fungus - Gloeosporium sp.): Anthracnose is more common on white oak group (Bur Oak, Over Cup Oak, White Oak and Post Oak) than on the other more common oaks. The disease is first observed in early summer, causing irregular, brown spots. These will most often be adjoining veins and midribs of the leaves. They may cover most of the leaf area. The blotches and spots are irregular, distortion of leaves, and papery texture are diagnostic characteristics. Late in the growing season dark pustules, formed by the fungus, can be seen on the veins and midribs of infected leaves.

The fungus develops at its optimum rate under warm, moist conditions during the spring months. Maximum growth occurs at 83°F and a relative humidity of 97 percent.

The fungus overwinters on dead twigs. To control anthracnose, destroy the diseased foliage, remove all dead twigs from the tree, and spray with a copper fungicide. Make first application when leaves are half grown and repeat in two weeks. The fertility program should also be increased to offset the weakening effect of continued defoliation.

Oak Leaf Blister (fungus - Taphrina caerulescens): Leaf blister is one of the major foliage diseases of oak trees in Texas. It is particularly damaging on red oaks and also attacks members of the white oak group. Leaves infected by leaf blister have discrete round, bulges in the leaf tissue with some cupping and twisting. The fungus overwinters on the bud scales. Infection will occur if the weather is cool and rainy during leaf emergence. The initial flush of leaves during extended periods of dry weather and above normal spring temperature are the only ones subject to infection by this organism. A copper fungicide just prior to bud opening is effective.

Actinopelte Leafspot (fungus - Actinopelte dryina): This disease is most severe on members of the red oak group but white oaks are also infected. The spots are small (2 to 5 mm in diameter), round and reddish-brown in color. The disease is most severe in late summer and early fall. Severe defoliation can occur. Actinopelte leafspot is a primary leafspot but can be found associated with other fungi. Infected leaves should be destroyed and trees which are severely defoliated by the fungus should be fertilized slightly more than normal to stimulate growth. Check foliage for possible minor element deficiency. Damage is sometimes associated with low levels of iron. Newly planted trees (first 3 years) are more subject to attack by this disease than well established trees.

Spot Anthracnose (fungus - Elsinoie quercus): Infection by this fungus can cause small spots on the foliage of red oaks. The spots are only on the upper surface of the leaf and are blackish-brown. The centers of spots are lighter in color and are generally 1 mm in diameter. Symptoms are first visible in early June and increase in number until the middle of August. By that time the foliage is severely damaged and the tree is a pale yellow. Defoliation occurs when infection is severe.
Sanitation is important in the prevention and control of this problem.

Remove all diseased leaves. Spraying is seldom required. Trees which have been severely damaged by the disease should be given additional fertilizer to stimulate new growth.

Powdery Mildew (fungi - *Microsphaera alni* and *Phyllactinia guttata*): Powdery mildew occurs on all groups of oaks. Infected leaves have a faint indistinct spot on the upper leaf surface and a white to off-white powdery growth on the lower side. The fungus will most often be found along the veins and midribs of the leaf. It is normally observed in late fall. Infected leaves will be slightly disfigured in severe cases.

Powdery mildew is seldom a problem on large individual trees. Damage can occur in nurseries and on low sucker limbs but rarely is disease sufficient to require spraying. Limb removal improves air circulation and will help reduce the occurrence of this disease.

Rust (fungus - *Cronartium strobilinum*): *C. strobilinum* (Southern cone rust) infects pines in mid-winter. The telial stage in only produced on an evergreen oak. They are thus closely associated with live oaks.

Infected oak leaves have yellow to orange pustules on the lower sides of the leaves. Severe infection may rarely cause defoliation. This most often occurs in late spring and early summer. The disease cycle is broken if the alternate host is removed; however, the spores can drift long distances between the oaks and pines. No control is normally required.

Hypoxylon Canker (fungus - *Hypoxylon atropunctatum* and other *Hypoxylon* spp.): The disease is first evident as a dieback of one or more branches. The foliage of the diseased limbs turns yellow and dries. This dieback continues from branch to branch through the stem until eventually the tree dies. This may require 1 or more years depending upon the environment and amount of stress experienced by the tree. Near death or shortly after tree death the outer bark sloughs off and exposes large masses of brown, dusty one-celled spores (conidia). These spores are gone within a few weeks and a grayish surface is visible. This is covered with numerous black fruiting structures. Mature fruiting structures (perithecia) can forcibly discharge sexual spores (ascospores) for distances of 60 mm. They are then blown to surrounding trees where infection occurs again. Entry appears to be through injured surfaces on limbs or trunk. The fungus grows best at 86^{o}F but can grow at 50^{o}F and 100^{o}F.

Hypoxylon canker causes a dark brown discoloration of the sapwood. With age the infected wood is lighter in color and has black zones or patterns in the wood when observed in cross section.

Hypoxylon canker occurs primarily on trees which are or have been in stressed conditions. Trees which have been damaged by excessive fill soil are often attacked by this organism. It is also suspected to be a fungus that can invade on oak wilt-infected trees.

Control is achieved by maintaining the trees in a healthy condition. Avoid injury to the trunk and limbs and never apply fill soil around the trees. Chemical treatments would not be effective because the fungus is located within the tree.

Physalospora Twig Blight (fungus - *Physalospora glandicola*): Affected trees look like they have been attacked by cicada. Dead shoots with attached brown leaves are found on the tree. The fungus enters through twig wounds. It eventually kills the twigs and branches. Although it causes noticeable damage to the tree, it seldom causes economic losses.

The fungus overwinters in cankers on twigs. Infected limbs should be removed and burned or destroyed during the summer. Make cuts 6 inches below the diseased area. Fertilization, watering and pruning should be practiced to encourage tree vigor.

Endothia Canker (fungi - *Endothia parasitica*, *Endothia gyrosa*): Post oaks and red oaks are particularly susceptible. It has been associated with pruning cuts or limb breakage. Removal of cankers by pruning and increased tree vigor helps reduce losses.

Canker Rots (fungi - *Irpex mollis*), *Polyporus hispidus* and *Poria spiculosa*): Infection by these organisms tend to cause circular cankers which have a depressed center rather than a conk or mushroom. The center of the canker is a brown punk. They will quite often form after a limb has been damaged or broken off.

To reduce canker rots, remove any dead limbs or limb stubs in a tree. Prevent any injury to trees that might serve as an infection site.

Burls (fungus - *Phomopsis* sp.): Large swellings on the limbs and trunk are caused by a species of *Phomopsis*. Burls can occur on both oaks and hickories. There are some swellings which occur on white oaks that aren't caused by a fungus but rather by the wood naturally growing over young buds and forming a gall or swelling.

True burls can be removed by pruning or in some cases by surgery. They do little or no damage to trees.

Oak Wilt (fungus - *Certocystis fagacearum*): This is an important disease of all oaks. Members of the white oak group die very slowly after infection occurs and can carry the fungus in the vascular system without showing any symptoms. Red oaks die rapidly after infection occurs. Symptoms show up on red oaks in early May as a bronzing of the leaves. On live oak, the leaf symptom is variable. The most common symptom is brown necrosis of the leaf veins. The remainder of the leaf may remain green or turn slightly yellow. Severe leaf drop occurs while the leaves are still green. Cuts made through the wood may show discoloration in the last annual ring. Symptom development usually begins on one limb or branch and in time spreads rapidly to the remainder of the tree.

The fungus may be carried from tree to tree by various insects and through root grafts. Sap feeding beetles are important in the short range spread. Red oaks which wilt in the late summer or early fall develop spore mats under their bark during the next spring. As the mats develop, the bark sloughs off or ruptures exposing the fungus. Insects are attracted to the mats. If the insects move from mats to healthy trees which have open wounds the fungus can then enter the healthy tree and move into the water conducting tissue.

Control is obtained by destroying diseased trees immediately. Remove or burn stumps. To prevent spread between trees, cut a ditch two to three feet deep around an infected tree. Vapam can also be used for this purpose. To apply the vapam, drill holes six to eight inches apart and 15 to 24 inches deep. The Vapam is diluted one part to four parts water and one cup of the mixture is applied to each hole. As soon as the hole is filled, it should be plugged with soil. Before using the Vapam treatment or making a ditch, the presence of Oak Wilt should be confirmed by a professional pathologist. This is a severe treatment and can result in plant damage if not done properly.

Oak trees should never be pruned during late March, April, May and early June.

Oak Decline (fungus - *Cephalosporium diospyri*): Live oak decline is a weak vascular pathogen of trees in Texas. Plants affected by the fungus first show signs of thinning out in the top of the tree which when first noticed, twigs in the upper portion of the tree show signs of dieback. The dieback will generally increase each year. As the dieback reaches the larger limbs which comprise the main canopy, sucker growth becomes evident on the main scaffold limbs. As the disease continues to progress, only the main scaffold limbs remain alive yet they also eventually die. This may take from five to ten years on Live Oaks, but less on other oaks after the first visual symptoms are observed.

Root grafting is suspected as one means of spreading the fungus. Recently, bark beetles have been associated with the spread of Oak Decline. The fungus has been isolated from the body of the suspect insects. If insects are involved this would explain the spread of the disease across areas too great for root grafting.

Live Oak, Post Oak, Water Oak, Texas Red Oak, Willow Oak, Sycamore, persimmon, Winged Elm, Hackberry, American Elm and Western Soapberry are reported to be hosts for Oak Decline.

A simple easy method of identifying Oak Decline is not now available. Laboratory isolations are not always satisfactory; this can lead to considerable difficulty in making any type of a reliable recommendation for control. For the most part, recommendations are based on positive identification of the problem. Mechanical injury to the roots can cause symptoms easily confused with disease caused by fungi. In newly built areas, the damage most often observed is from root injury.

Step to Reduce Live Oak Decline Losses:

1. Identify the problem.
2. Reduce the stress conditions that weaken trees.
3. Optimize fertilizer and water applications to tree.
4. Remove dead limbs on tree.
5. Do not import wood from Oak Decline infected areas as it could be a source of the disease spread into a previously disease free area.
6. Use trees not known to be a host of Oak Decline.

Cotton Wood	Pine	Baldcypress

Arizona Cypress	Willow	Walnut
Hickory	Magnolia	Cedar
Pear (Bradford)	Osage-orange	Sweetgum
Mimosa	Crab Apples	Mesquite
Hercules Club	Redbud	Honey locust
Dogwood	Chinaberry	Boxelder
Palms	Mountain Laurel	Catalpa
Chinese Tallow	Oriental Oaks	Quercus ilex
Chinese Holly	Quercus acutisimon	

This is a list of trees not currently known to be hosts for Oak Decline. In selecting trees, you should contact the County Extension Agent in your county for those trees that do well.

Wetwood (bacterium- Erwinia nimipressuralis): Affected trees exhibit a sapflow from crotches. The bark below the crotch has a watersoaked appearance. The sap flow is the result of bacterial by-products producing abnormally high pressures within the vascular system. For more information on wetwood and its control, refer to the section on elms.

Ball Moss: (See section on "Plants That Grow on Other Plants")

Lichens: (See section on "Plants That Grow on Other Plants")

Tar Spot: (fungus - Morenoella quercina): Black spots up to 1/4 inch in diameter occur on shaded live oak branches. Prune low hanging branches to improve air circulation. Raking and destroying fallen leaves may reduce the problem.

PINE

Pinus spp.

Fusiform Rust (fungus - *Cronartium fusiforme*): A fungus disease with alternate reproductive stages on pine and oak. Symptoms on pine are spherical, oblong or linear swellings or galls on branches or trunks. Swellings on trunks may develop into open cankers. Multi-branching frequently occurs in the vicinity of swellings which rupture to release quantities of orange spores. Remove galls on specimen trees by pruning. Remove infected trees in planted forests during thinning operations. In nurseries, begin fungicide sprays when oak trees in the area start to leaf out and continue through May. Late planting will reduce infections. When possible, locate seedbeds in the vicinity to reduce oak and subsequent pine infections. Slash Pine is highly susceptible; longleaf and Texas selections of loblolly are moderately resistant.

Annosus Root Rot (fungus - *Heterobasidion annosum*): Symptoms of this fungal disease are stunted needle growth and thinning of needles in the crown. Roots and butt of stems exhibit a soft, stringy white rot. The causal fungus produces perennial conks or fruiting bodies at the base of the tree or in crotches of the root collar. The conks vary in shape from a bracket to flat layers. These are gray-brown to dark brown on the upper surface, creamy white underneath, and usually are not casually visible due to covering by needle accumulations. The disease is most serious in planted forests following thinning operations. Infections spread from infected stumps to healthy trees through root grafts. Common borax powder applied in salt shaker manner to surfaces of freshly cut stumps prevents stump infection and subsequent spread to adjacent living trees. Harvesting during dry summer and fall months whenever possible lessens the possibility of new infections.

Brown Spot Needle Blight (fungus - *Scirrhia acicola*): This disease is a problem on seedlings. Damage to large trees is usually minor. Symptoms first appear as irregularly circular light gray-green spots on needles in the fall. Spots enlarge rapidly and encircle the needle forming narrow tan-brownish bands, and finally the tips of the needles die as a result of multiple infections. Many needles may be killed the first season they are infected. The fungus fruits on very small dark-brown to black colored elongated spots on the dead part of the needle. Spores are produced in wet weather and the needles may be attacked several times in one season. At least three successive annual defoliations must occur to kill longleaf pine seedlings. The best control in longleaf plantations is obtained by controlled winter burning until seedlings are above 18 inches high (the brown spot danger level). Brown spot does occur on slash and loblolly, but is most serious on longleaf pine. In nurseries and on valuable specimen trees apply fungicidal sprays at two week intervals, during humid weather, from April 15 through May.

Seedling Blight or Damping-Off (fungi - *Pythium* sp., *Rhizoctonia* sp., *Sclerotium* sp., *Fusarium* sp., and *Cylindrocladium* sp.): These fungi usually live on dead organic matter in the soil but they can become virulent parasites of living plants. They attack young seedlings at, above, or below the soil line. Several things can be done to control damping-off. Locate nurseries on light sandy soils, because damping-off fungi flourish in heavier, wetter soils. Raise seed beds so they will quickly drain after a rain. Mix oak or pine leaf mulch into the seed beds to about two percent of soil volume. Mulch the seed beds with pine needles. Do not ship trees from one nursery to another to prevent the introduction of fungi. Use fungicide drenches. Fumigate soil prior to planting with methyl bromide or other approved soil fumigant. Pellet the seeds with a seed treatment fungicide using methyl cellulose as a binder.

Needle Curl (physiological): Ends of needles curl in an abnormal manner. The cause is attributed to water stress.

Coleosporium Rust (fungus - *Coleosporium asterum*): Present in Texas on loblolly and slash pine. The alternate stage is on various composites, particularly aster and goldenrod. Symptoms on pine are small fragile white "blister-like" structures that erupt through the needle surface. These structures break to release thousands of small pinkish to orange spores. Damage is seldom severe enough to warrant any form of control.

Wood Rots: Discoloration, softening, crumbling and disintegration of wood may be caused by a variety of fungi. Prevent damage from fire, insects, machinery and unfavorable environmental situations. Remove diseased trees. Plant trees adapted to the locality. Avoid introducing foreign species of trees unless inspected and approved by forestry personnel.

REDBUD

Cercis spp.

Canker (fungus - Botryosphaeria dothidea): The most destructive disease of redbud. Cankers begin as small sunken areas and increase slowly in size. The bark in the center blackens and cracks along the edges. The canker girdles the stem and the leaves above wilt and die. Prune and burn branches with visible cankers.

Leaf Spot (fungus - Mycosphaerella ceridicola with a Cercospora stage): The leaf spots are brown, circular to angular, from one-eighth to one-fourth inch in diameter, often with a halo. Premature defoliation may occur. Apply a fungicide labeled for general use on trees and shrubs, at 10 day intervals when spots first appear and during prolonged periods of wet weather.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Redbud is rated as highly susceptible to the cotton root rot fungus.

Verticillium Wilt (fungus - Verticillium albo-atrum): (See section on Verticillium Wilt.)

Sooty Mold: (See section on Sooty Mold.)

Wood Rot: (See section on Wood Rot.)

SYCAMORE

Platanus spp.

Wilt (fungus - Cephalosporium diospyri): This fungus has been found repeatedly in large sycamores. The fungus, when introduced into seedlings, produces symptoms including sudden wilting and browning of leaves, sudden blighting of twigs forming "shepherd's crooks", yellow discoloration, and defoliation. How widespread this fungus is in Texas sycamores is not known.

Botryodiplodia Canker (fungus - Botryodiplodia theobromae): This fungus is known generally as a weak or facultative parasite with a wide host range. However, in Texas it has caused a rapid death of sycamores. The fungus produces cankers on branches and the main stem. It is favored by high temperatures and drought stress conditions. Trees weakened by the Cephalosporium wilt fungus are more vulnerable to attack. Broken terminals in twigs are the best places for the fungus to enter. It has been a common problem in sycamores. Prune out dead and dying branches below the cankers. Sterilize pruning tools with 10 percent bleach solution between cuts. Spraying for anthracnose with benomyl will also help to control Botryodiplodia.

Sycamore Anthracnose (fungus - Gnomonia plantani): Sometimes called blight and scorch. A single attack seldom causes harm but if the tree is infected several years in succession it will weaken a tree, making it susceptible to borer attack and winter injury. The first symptoms, sudden browning of single leaves or clusters, may be confused with late frost injury. Later dead areas appear along or between the veins, usually starting at the leaf edge. Leaves fall prematurely when heavily infected and trees often remain bare until late summer, when new leaves form. Infection of small twigs causes sunken areas, called cankers, and slightly raised margins. When the canker completely girdles the twig, killing it, this is called the shoot blight stage.

The fungus can overwinter in fallen infected leaves and in twig cankers. In southern Texas it can pass the winter in the spore stage on dormant buds. Severity of attack depends on weather conditions during the two week period following leaf emergence. Frequent rains and cool temperatures favor rapid spread. Below 55°F. injury will be severe and above 60°F, little or no injury.

Control: Prune out dead twigs in fall. Burn all dead twigs and fallen leaves. Spray with recommended fungicide when leaves unfurl, when leaves are half-grown, and when leaves are fully grown.

Trees repeatedly attacked should be well fertilized in spring to increase their vigor.

Leaf Spot (fungi - Mycosphaerella platanifolia, Phyllosticta plantani, and Septoria platanifolia): Several fungi cause disease of minor importance that can be controlled by the spray schedule suggested for control of anthracnose. Phloeospora multimaculans: known mainly in Texas. Irregular, dark brown to purple spots one-eighth to one-fourth inch in diameter on the upper leaf surface. Often with a brown center. Spots are brown with darker border on lower surface. Spots may coalesce to produce a dirty-brown colored leaf. Defoliation may occur.

Powdery Mildew (fungi - *Microsphaera alni* and *Phyllactinia guttata*): Makes appearance mainly in late summer. May be present on older growth but usually most severe on new growth, which may be distorted, stunted, and covered with a white growth and white spores.

Canker-Stain Disease (fungi - *Ceratocystis fimbriata f. sp. plantani*): It can be lethal to sycamore, but is much more important as a killing disease of London plane (*Platanus acerifolia*): Since it is spread almost entirely by man, through pruning, it is essentially a shade tree disease. Leaves are dwarfed and sparse in part or all of the tree top. The staining cankers occur on trunks or branches. pThe first symptom on the yellow or green bark is a brown to black lens-shaped discoloration. Cankers may become 20 to 40 inches long in one year, but usually only two inches wide. Cankers widen each year, and often coalesce, girdling the tree or branch. Older cankers shed their darkened, dead bark exposing the wood, which dries, cracks, and turns black. The reddish-brown or bluish-black discoloration of the wood, in cross section behind the cankers, is the most distinctive symptom. Stain patterns are radial, generally reaching the pith. The fungus sporulates abundantly on newly-killed wood in wet weather from May until October. It produces two kinds of asexual spores; one, long and clear; the other, short and brownish. It also produces a long-necked, pear-shaped, sexual fruiting structure. Avoid injuring the tree. Prune out dead limbs during winter. Be sure to dip the pruning tool in 10 percent bleach solution before each cut to avoid spreading the fungus. Treat cankers with protective paint.

Sooty Blotch (fungus - *Gloeodes pomigena*): Sometimes forms on shoots of sycamore. The dark surface mycelium can usually be rubbed off with the fingers.

Mistletoe (parasitic plant - *Phoradendron serotinum*): A seed-producing higher plant that parasitizes sycamore in the south.

Shoestring Root Rot (fungus - *Armillaria mellea*): Two forms of the fungus can usually be found under the bark at ground level. These are black "shoestring like" rhizomorphs and a white fan-shaped fungus growth. (See Mushroom Root Rot section.)

Cotton Root Rot (fungus - *Phymatotrichum omnivorum*): (See Cotton Root Rot section.)

Trunk Rots (fungi - *Hydnum erinaceus*, *Fomes* sp., *Ganoderma* sp.): Heart rot fungi can hollow out the entire central cylinder of a tree. The tree declines in general and the presence of the fungus is known when it fruits on the side of the tree. The annual fruiting structure is a white, rounded, spongy mass with long, slender white teeth on the bottom. There is no control - only prevention, by avoiding wounding the tree. (*Fomes applanatus*): This fungus enters wounds and causes a white, mottled trunk rot. The tree declines in general and the presence of the fungus is known when it produces a fruiting structure from a wound. This hard, woody, shelf-like perennial structure may attain a width of two or more feet. The upper surface is smooth, zoned, and grayish or grayish black, whereas the undersurface is white when fresh, but becomes yellowish with age. The undersurface turns brown when bruised and is a favorite medium for artists. There is no control - only prevention, by avoiding wounding of the tree.

WILLOW

Salix spp.

Bacterial Twig Blight (bacterium - Pseudomonas saliciperda): Leaves turn brown and wilt and blighted branches die back for several inches. Brown streaks can be seen in sections of the wood. Bacterium overwinters in the cankers, so young leaves are infected as soon as they unfold. The damage can be confused with frost injury. Prune out infected twigs and spray in early spring with an approved fixed copper fungicide.

Crown Gall (bacterium - Agrobacterium tumefaciens): Mainly a nursery disease. Large, rough, woody swellings or galls on the lower part of the stem and crown of the plant. Infected plants may be deformed, stunted or even killed. Weeping willow is susceptible. No practical control is known for this disease.

Cytospora Canker (fungus - Cytospora sp.): Affects willows the same as poplars. Discolored, sunken, often sharply defined areas develop on twigs, branches or trunk. Cankers enlarge and gradually girdle infected parts causing death to portions beyond. Weeping willow is susceptible, but rarely occurs on black willow. Prune out and destroy dead and cankered parts. Spray with an approved fixed copper fungicide.

Leaf Spots (fungi - Cercospora sp., Gloeosporium sp.): Small to large, round to irregular spots of various colors on leaves. Leaves may wither and drop early. Begin spraying when buds begin to swell in the spring.

Rust (fungus - Melampsora sp.): Lemon-yellow spots on lower leaf surface. Later in the season the pustules are dark colored. The disease may be severe enough to cause leaf drop. Although rust infections are not considered serious, they may result in heavy defoliation of young trees.

Powdery Mildew (fungi - Phyllactinia guttata and Uncinula salicis): White powdery growth on leaf surfaces may become heavy late in the season, especially on tender leaves of sprouts.

Tarspot (fungus - Rhytisma salicinum): Spots are very thick, jet black, discrete and about one-fourth inch in diameter. It looks like a drop of tar on the leaf. Rake up an burn dead leaves, as the fungus overwinters on them. Spray early in April with a fungicide.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Most willow species are highly susceptible. Plants suddenly wilt and die, leaves usually hanging on the plant. Roots will be decayed with the bark peeling off very easily. (See section on Cotton Root Rot.)

WOOD ROTS ON SHADE TREES

Wood decay is common on many species of shade trees. Wood decay fungi usually enter the tree through wounds. Most fungi grow rather slowly showing no evidence of being present until extensive areas are rotted. Most will first invade the non-functional heartwood. After decay is well advanced in the heartwood, they may invade the living sapwood.

When the fungus has developed extensively, fungal fruiting structures, commonly called shelf fungi or conks, may appear on the trunk. Some fungi may form mushroom-type structures at the base of the trunk or form on major roots, rather than on the trunk.

Where extensive wood rot has already occurred, the rotted wood should be completely removed. The cavity then should be sprayed with a fungicide and filled by a reliable and experienced tree surgeon.

Improper pruning or failure to remove wind damaged branches is a common problem that results in fungal infection. Do not leave branch stubs. Cuts should be made even against the trunk so that callous tissue can grow over the wound. Cuts should be made so that the scarred area will never collect and hold water.

Consult the Chemical Control Supplement (B-1140A) for specific chemical control suggestions.

CEREAL CROPS

BARLEY

Hordeum vulgare

Net Blotch (fungus - *Pyrenophora teres*): Net blotch of barley is principally a leaf disease and is of the kind that is generally known as leaf spot. The spots are internal with a characteristic netting. The netted pattern, formed by the arrangement of brown pigment in transverse and longitudinal lines, can best be seen if the leaf is held against the light. The elongated, brown-netted areas finally cover most of the leaf and destroy it usefulness. The fungus causing net blotch may be carried on the seed or infection may come from old straw. Crop rotation, burying old straw, and seed treatment will aid in prevention of this disease.

Spot Blotch (fungus - *Bipolaris sorokiniana*): Spot blotch infection starts as dark brown-to-black spots on sheaths that cover the young shoots. The infection progresses inward and sometimes kills the seedlings below the surface of the ground, but more often it kills the seedlings after emergence. Diseased seedlings are dwarfed and tiller excessively. Roots of diseased plants may show rotting with brown spots.

As crown rot, the disease develops at or near the soil line. Crown roots may be rotted and tillers killed. The pathogen can be soil- or seed-borne, and may be carried on crop residue. Seed treatment with a fungicide reduces losses from seedling infection. Burying crop residue and crop rotation will aid in control.

Powdery mildew (*Erysiphe graminis*); Gray, fluffy threads of the fungus can be observed on the upper surface of the leaves and leaf sheaths. The fungal strands penetrate and invade the leaf tissue. As the disease progresses, the leaf turns yellow and is gradually killed. Spores of the fungus are carried from plant-to-plant by wind currents. While the disease can be controlled with fungicides, such controls may not be economical.

Leaf Blotch (fungus - *Septoria passerinii*): The spots characteristic of leaf blotch are elongated and yellowish-brown, and their ends have indefinite margins. Numerous dark-brown fruiting bodies develop in rows between the veins in the dead, straw-colored parts of the spots. Control is the same as for spot blotch.

Leaf Rust (fungus - *Puccinia hordei*): Small, round yellow or yellowish-brown pustules appear on the leaves. Infected leaves eventually die. Leaf rust of barley does not infect oats or wheat. The development of resistant varieties is currently the only practical means of control.

Stem Rust (fungus - *Puccinia graminis*): Pustules break through the stem and leaf tissue. Rusted stems turn brown, become dry and brittle and may lodge. Control is the same as for leaf rust.

Smut (fungi - *Ustilago hordei*, *U. nigra*, *U. nuda*): Three smuts occur on barley in Texas, but with seed treatment fungicides now available, each can be controlled. Covered smut (*U. hordei*) is noticed at heading time. Hard, black masses of smut, each covered with a grayish membrane, are found in place of kernels. Semi-loose smut (U. nigra) destroys the floral parts and entire head. Spores of the nigra smut are carried within the husk covering or on the seed. Loose smut (U. nuda) is similar to semi-loose smut except the smut fungus is internally seed-borne.

Barley Yellow Dwarf Virus (virus): Yellowing of leaves is the first visible sign that a plant is diseased. When infection occurs in a plant during the seedling stage, the leaves turn a bright golden yellow, usually beginning at the tips and progressing back along the edges. In very susceptible varieties, plants infected in the seedling stage are severely dwarfed and may grow less than six inches tall. They produce more tillers than healthy plants but form no heads. Several species of aphids can carry the virus from infected grasses to barley.

Barley Stripe Mosaic (virus): Barley stripe mosaic is a seed-borne virus which causes yellow or light-green stripes or streaks of the leaves.

Foot Rot, Take-all, and Rhizoctonia Root Rot and Sharp Eyespot: These diseases affect both barley and wheat and are described in the wheat section.

Basal Glume Blotch (bacterium - Pseudomonas atrofaciens): Basal glume blotch on barley is caused by a bacterium. It is caused by the same bacterium that occurs commonly on wheat. The symptom of basal glume blotch is dull brownish-black, discolored area found at the base of each glume covering the kernel. The discoloration is more pronounced on the inside than on the outside of the diseased glume. The base of a diseased kernel shows a discoloration varying from faint brown to charcoal black with the color depending upon the severity of the attack. Leaves affected by this disease organism show small, dark, water-soaked spots. These spots tend to enlarge and turn yellow and finally brown as the tissue dies. The use of clean and treated seed will reduce the severity of this disease.

Nematodes: Lesion, spiral, stubby root and stunt nematodes feed on the roots and can result in poor root development. Plants will be stunted and in most cases show an off-color as a nutritional deficiency. Frequent turning of the soil during summer months tends to lower populations.

BARLEY

Variety	Leaf Rust	Powdery Mildew	BYDV	Net Blotch
Dundy	S	R	MS	MS
Era	MS	MR	MS	MS
Kanby	MS	MR	MS	MS
Paoli	MR	R	MS	S
Post	S	R	MS	S
TAMBAR 401	MR	MR	MS	S
TAMBAR 402	MR	MS	MS	MS
Will	S	R	MR	MS

R = Resistant
MR = Moderately resistant
MS = Moderately susceptible
S = Susceptible

[Blank Page in Original Bulletin]

CORN DISEASES

An Aid to Identification and Control

1. BROWN SPOT

2. HELMINTHOSPORIUM LEAF SPOT

3. VIRUS DISEASE

4. SMUT

5. EAR ROT

6. NEMATODE DAMAGE TO ROOTS

7. CHARCOAL STALK ROT

8. STALK ROT AND LODGING

9. FUSARIUM STALK ROT

PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

[Blank Page in Original Bulletin]

CORN

Zea mays

Seed Rots and Seedling Blight (fungi - several species): Germinating corn seed may be attacked by soil- or seed-borne fungi which cause seed rots and seedling blights. Seedling diseases are prevalent in poorly drained, cold and wet soils. Disease severity is affected by planting depth, soil type, moisture, temperature and seed quality. Sweet corn is more susceptible than field corn. Symptoms may be confused with mechanica or chemical injury or insect damage. Symptoms may be seen as:

Seed Rot: Rotting of seed before germination.

Damping Off and Seedling Blight: Soft rot of stem tissues near ground level and watersoaking of tissues. The rotted area may be dark, whitish-gray, white, pink or bluish.

Seedling Wilt: Gray coloration starting at the eaf tips and extending rapidly to the whole leaf, causing complete collapse of seedlings in 27-48 hours. This symptom may indicate kernel infection caused by *Bipolaris maydis*.

Root Rot: Watersoaking, browning and sloughing of rootlets. The rot may advance into main roots and crown tissues.

Control:
1. Plant high quality, injury-free seed.
2. Plant seed in warm, fairly moist soil with proper seedbed preparation; use correct placement of fertilizer, herbicide and other pesticides.
3. Use seed protectant fungicides.

Stalk Rots (fungi - severa species): Stalk rots are universally important and among the most destructive diseases of corn throughout the world. In most cases rots are caused by a complex of fungi and bacteria that attack plants approaching maturity. Loss to stalk rots may vary with the season and the region where they occur. Yield reductions of 10-20 percent are common under severe diseases. Losses may be direct through poorly filled ears and low test weights or indirect through harvest losses because of stalk breakage or lodging. The development of stalk rots is favored by dry weather early in the growing season followed by extended periods of rainfall shortly after silking. Unbalanced fertility, poor soil drainage, mechanical and insect damage, variety or hybrid, plant density and row spacing all influence disease prevalence and severity. Some stalk rotting fungi also cause root and ear rots as well as seedling blights.

Control:
1. Plant sound, disease-free seed.
2. Use crop rotation and sanitation.
3. Apply fertilizer having balanced soil ratios between N and K, according to soil test.
4. Control insects with chemicals, resistant varieties and cultural practices.
5. Grow resistant varieties adapted to the area.
6. Use cultural methods such as planting in warm soils and early harvest and drying.

7. Adjust stand densities to variety, soil type, fertility and moisture availability.

Ear and Kernel Rots (fungi - several species): Corn is susceptible to many ear and kernel rot organisms, some of which are widely distributed. These rots cause considerable damage in humid areas, especially when rainfall is above normal from silking to harvest. Moldy corn may contain toxic materials produced by certain fungi, causing a total loss of the crop. (See the section on mycotoxins for detailed information.) The prevalence of rots is increased by insect and bird damage to ears and stalks, and by lodging where ears touch the ground. Ears well covered by husks and maturing in a downward position usually have less rot than ears with open husks or maturing upright. Ear and kernel rots can reduce yield, quality and feed value of the grain. They may generally be prevented by maintaining proper fertility and moisture, timely harvest and proper storage.

Common Smut (fungus - *Ustilago maydis*): All aboveground parts of the plant are susceptible, particularly young, actively growing tissues. Symptoms are easily recognized. Galls are at first covered with a glistening, greenish to silvery-white membrane. The interior of these galls darken and turn into masses of powdery, dark olive-brown to black spores. As galls mature they may reach 6 inches in diameter. Galls on leaves usually remain small, become hard and dry, but do not rupture. Early infection may kill young plants. Plants with galls on lower stalks may be barren or produce several small ears. The development of common smut is favored by dry conditions and temperatures between 78^{o} and 95^{o}F. Disease incidence may be higher among plants grown in soils high in nitrogen or after heavy manure applications. Injuries due to hail, blowing soil particles, cultivation, buggy-whipping or detasseling in seed fields greatly increase the occurrence of smut.

Control:
1. Avoid planting highly susceptible varieties.
2. Avoid mechanical injury to plants during cultivation.
3. Maintain well-balanced soil fertility.
4. Remove galls from infected plants in home gardens before they rupture.

Head Smut (fungus - *Sporisorium reilianum*): Corn and sorghum can be infected with this soil-borne fungus. It first appears when ears and tassels are formed. Floral structures may be completely converted to masses of brownish-black spores. Tassel infection may be confined to individual spikelets causing shoot-like growth on the tassel. Ears of infected plants may be smutted or aborted with leafy buds replacing normal ears. Galls develop only in tassels and ears. Tassels may remain healthy while smut forms in the ears but such plants do not produce pollen. Head smut galls form around heavy strands of vascular tissue which remain as the gall disintegrates. Infected plants produce no grain.

Control:
1. Use resistant varieties or hybrids.
2. Use good sanitation and rotation.

Crazy Top (fungus - *Sclerophthora macrospora*): Symptoms vary greatly with time of infection and degree of colonization by the fungus. Generally, excessive tillering, rolling, and twisting of upper leaves appear first.

The most characteristic symptom is the partial or complete proliferation of the tassel which continues until the tassel resembles a mass of leaves described as "crazy top". Leaves of severely infected plants are often narrow, strap-like and leathery. Stunting and chlorotic striping of leaves are other common symptoms. Crazy top develops where corn fields have been flooded before plants reach the four to five leaf stage. Crop losses generally are confined to very localized areas.

Control: Avoid low-lying, wet areas with poor drainage.

Sorghum Downy Mildew (fungus - *Peronosclerospora sorghi*): Systemically-infected plants are chlorotic, stunted and occasionally have white striped leaves. Some leaves may have a sharp, transverse margin between diseased and healthy tissue giving a "half diseased leaf" appearance. Leaves of infected plants are narrower and more erect than those of healthy plants. Downy growth may appear on both surfaces of infected leaves and diseased plants may have "bushy" tassels. Plants of tolerant varieties may show symptoms of systemic infection but have normal seed production. Long narrow, chlorotic, local lesions develop on some varieties. The fungus survives several seasons in soil. Spores can be windborne to other corn and sorghum plants.

Control:
1. Avoid (when possible) planting in fields where the disease is a problem.
2. Use resistant hybrids.
3. Use a systemic fungicide seed treatment in problem fields.

Brown Spot (fungus - *Physoderma maydis*): Brown spot is generally of minor importance although serious localized outbreaks have been reported. Lesions first appear as very small, oblong to round, yellowish spots on leaves and sheaths. Lesions may occur in bands across the leaf blade. Infected tissues turn brown to reddish brown and coalesce to form large, irregular blotches. Cells of infected tissues disintegrate and expose golden brown to dark brown spores. Stalks infected at nodes beneath the sheaths frequently break at infection centers.

Common Rust (fungus - *Puccinia sorghi*): Pustules are most abundant on leaves. The circular to elongate, golden to cinnamon brown pustules are powdery and sparsely scattered over both leaf surfaces. They become brownish black as the plant matures. Cool temperatures and high relative humidity favor rust development and spread. Some inbred lines show a resistant flecking at leaf tips with pustules developing on leaves in the whorl at the time of infection. Older tissue is generally resistant. Numerous physiologic races have been identified.

Control:
1. Use resistant varieties.
2. Apply fungicides when economically feasible.

Southern Corn Rust (fungus - *Puccinia polysora*): Southern rust is potentially much more damaging than common rust because its development is more rapid and more destructive to leaf tissue. It occurs in a smaller geographic area than common rust, primarily along the Coastal Bend and as far north as Hempstead. Symptoms are similar to those caused by common rust, but can be distinguished by certain characteristics of the leaf surface. Southern rust pustules are more orange in color, smaller and more circular than those caused by the common rust fungus. Pustules are numerous on the leaf surface and cause the leaf to turn yellow and die prematurely. Heavy infection while ears are filling can cause drastic yield reductions. The disease develops most quickly when high temperature and high relative humidity occur in a field planted to a susceptible hybrid. Unlike the common rust fungus, southern rust is favored by temperatures around 80°F. Where southern and common rust have been observed in the same field, the southern rust development is slower. Corn hybrids vary in susceptibility to this disease, but most seem to be affected to some degree. If southern rust is a consistent problem, a high yielding, resistant hybrid should be planted. If chemical control is needed, growers should select cleared fungicides which may be effective.

<u>Southern Corn Leaf Blight</u> (fungus - <u>Bipolaris maydis</u>): Southern corn leaf blight was a very minor disease on corn for many years. A few lesions would appear only on leaves but there was no economic effect on yield. In 1970, however, a highly virulent strain called Race T appeared on corn hybrids with Texas male sterile cytoplasm. Losses were severe because of this new race. The disease is still a threat to susceptible hybrids but all hybrids with normal cytoplasm are resistant and resistance is now available in hybrid seed produced on male sterile plants. Race T lesions are spindle-shaped or elliptical, with yellow-green or chlorotic halos. They may later have dark, reddish-brown borders and may occur on leaves, stalks, leaf sheaths, ear husks, shanks, ears and cobs. A black, felty mold may cover affected kernels. Seedlings from infected kernels may wilt and die within three to four weeks after planting. Cob rot can occur with substantial losses in harvesting and shelling. Early shank invasion can cause premature kill of the ear and possible ear drop. The fungus overwinters as mycelium and spores in corn debris in the field and on kernels in cribs, bins and elevators. Conidia are carried by wind or splashing water to growing plants where primary infections occur. Sporulation on diseased plants leads to a rapid spread in the field. The disease cycle can be completed in about 60-72 hours under ideal conditions. Infected grain is not toxic to livestock.

Control: 1. Use resistant hybrids.
2. Use fungicides under appropriate special conditions such as seed corn production.

<u>Northern Corn Leaf Blight</u> (fungus - <u>Exserohilum turcicum</u>): Another major foliar disease of corn is northern corn leaf blight. The organism causes long, elliptical, grayish green or tan lesions which develop first on lower leaves. The disease progresses upward causing premature death resembling frost or drought injury. In damp weather, large numbers of grayish black spores are produced on the lesions of susceptible varieties. Ears are not infected, although lesions may form on the outer husks. The disease overwinters in infected leaves, husks and other plant parts. Spores are windborne over long distances to leaves of corn plants. Secondary spread within and between fields occurs by spores produced abundantly on leaf lesions. Disease development is favored by moderate temperatures and heavy dews during the growing season. If the disease is established before silking, losses will be higher; but if infection is delayed until six weeks after silking, yield losses will be minimal.

Control: Use resistant varieties. Fungicides may be applied where appropriate, starting when lesions are first found. Chemical control is usually not justified, however.

Nematodes: More than 40 species of nematodes have been reported breeding in association with corn roots. In general, nematodes decrease the efficiency of the root system resulting in reduced growth, chlorosis and poor yields. Injury symptoms vary with nematode species, size of nematode population, soil conditions and age of plant. The main symptoms on corn are plants lacking vigor and dark, discolored areas in the root system. Lesion size increases with continued nematode feeding and invasion by soil microorganisms.

Control: Rotate crop with non-host plants.
Use chemical control where practical.

Maize Dwarf Mosaic Virus (virus - maize dwarf mosaic virus (MDMV): This is the most common and damaging virus disease of corn in Texas. Symptoms first appear on the youngest leaves as irregular, light and dark green mottle or mosaic which may develop into narrow streaks along veins that appear as dark green "islands" on a chlorotic background. As plants mature, leaves become yellowish green. Plants are sometimes stunted with excessive tillering, multiple ear shoots and poor seed set. Early infection may predispose corn to root and stalk rots and premature death. Symptoms can appear in the field within 30 days after seedling emergence. The virus is transmitted mechanically and by at least 12 aphid species, including the green bug. It has a wide host range among wild and cultivated grasses. Johnsongrass is believed to be a major overwintering reservoir host.

Control: Use resistant varieties and control Johnsongrass in and around the field.

Bacterial Leaf Blight (bacterium - Erwinia stewartii): Bacterial leaf blight is sometimes called Stewart's bacterial wilt, Stewart's leaf blight or maize bacteriosis. It is not common in Texas. Infected sweet corn wilts rapidly and resembles plants suffering from drought, nutritional deficiency or insect injury. Leaves show linear, pale green to yellow streaks with irregular or wavy margins which parallel veins and may extend the length of the leaf. These streaks soon become dry and brown. Infected plants may produce premature, bleached and dead tassels. Cavities may form in the stalk pith of severely infected plants near the soil line. In such plants, bacteria spread throughout the vascular system, sometimes passing into kernels. the bacterium is spread during the feeding of several chewing insect pests including flea beetles, wireworms, root worms and May beetles. Field corn is generally more resistant than sweet corn.

Control: Use resistant hybrids.
Control insects.

OATS

Avena sativa

Crown or Leaf Rust (fungus - *Puccinia coronata* f. sp. *avenae*): The disease appears as tiny, round, yellowish-red pustules on either surface of the leaf blade. These pustules produce tiny yellow-red spores that are spread to other plants by wind currents and germinate in free moisture from dews and rains. Crown rust, like other rusts, is caused by a fungus that attacks the leaves and leaf sheath of oats and related grasses. Grazing the infected crop is a suitable means of salvaging value from the crop when damage is heavy.

Stem Rust (fungus - *Puccinia graminis* f. sp. *avenae*): The pustules of stem rust are usually oblong and dark reddish-brown. The epidermis is ruptured and often pushed up around the edges and through the center of the pustules so that it is easily visible. The dark color of the stem rust pustule distinguishes it from the light, orange-yellow crown rust.

Smuts (fungi - *Ustilago avenae* and *Ustilago kolleri*): Loose smut (*Ustilago avenae*) and covered smut (*Ustilago kolleri*) are two of the most common and widespread of the smut diseases of oats. The smut balls of loose smut form in the oat panicle usually destroying most or all of the seed and hulls. Wind and rain usually dislodge most of the spores soon after they appear and infected panicles are often inconspicuous in the field. The smut balls of covered smut do not ordinarily destroy the outer hulls and the spore masses remain more or less intact inside the hulls until threshing time. Seed treatment with recommended fungicide will prevent both type smuts.

Leaf Blotch, Victoria Blight, Culm Rot (fungi - *Drechslera avenacea*, *Bipolaris victoriae*, *Bipolaris maydis*): Three species of fungi cause economically significant diseases of oats. With leaf blotch, oblong, linear blotches appear on the leaves. The blotches are light-yellow at first, later turning red to brown. Victoria blight is a seedling blight and sometimes seedlings are killed soon after they emerge. In other cases, plants are stunted, leaves turn red and lower leaves eventually die. Culm rot is a basal stem and root rot. Seed treatment and crop rotation will help prevent this disease.

Powdery Mildew (fungus - *Erysiphe graminis*): This fungus disease appears as patches of white, fluffy growth on the lower leaves and leaf sheaths. No practical control measure is available. Grazing excessive growth will allow light and air to keep the plants dry, thus reducing the severity of powdery mildew.

Septoria Leaf Blotch (fungi - *Septoria* sp.): Leaf blotches are gray to dark-brown and run together. Spots on the stem are black and may cause the plant to lodge. The hulls of grain may sometimes become infected and turn black. Use seed treatment fungicides, crop rotation and bury crop residue.

Barley Yellow Dwarf Virus: Plants are dwarfed and can be either brilliant red or yellow. Symptoms usually appear following a high population of aphids and small grain greenbug. (See Yellow Dwarf of Barley)

Halo Blight (bacterium - *Pseudomonas coronafaciens*): Lesions or spots appear on leaf blades as oval to oblong water-soaked spots that are buff to light brown in color. A light-yellow zone forms a halo around the brown lesion. The bacterium enters the leaf tissue through stomata or an insect puncture. Suggested controls are seed treatment, crop residue management and rotation.

Nematodes: (See section on Barley)

OATS

Variety	Crown Rust	Stem Rust	Halo Blight	Winterkill
Big Mac	MS	S	MS	MR
Bob	S	MS	MS	MR
Coker 234	MS	S	MS	MR
Coronado	MS	MR	MS	MS
Florida 501	S	MS	MR	MS
H-422	MR	S	MR	MR
H-833	MS	S	MR	MR
Mesquite	MS	S	MR	MR
Nora	S	S	MR	MR

R = Resistant
MR = Moderately resistant
MS = Moderately susceptible
S = Susceptible

GRAIN SORGHUM

Sorghum vulgare

Seed Rots and Seedling Diseases (fungi - Rhizoctonia solani, Fusarium sp., Pythium sp. and others): Seed rots and seedling diseases usually occur when weather and soil conditions are unfavorable for seed germination and seedling growth. Organisms that cause seedling disease are favored by such conditions and find the weakened seed or seedling to be a good food source. Other factors such as poor seed quality or improperly placed fertilizer or herbicide often contribute to the problem. Continuous growth of one crop over a period of years may favor buildup of organisms that cause seedling disease. Proper management of crop residue to keep it out of the seed germination zone is helpful. Use high quality seed treated with a recommended seed protectant. Precision planting to insure proper depth in a well-prepared seedbed is most helpful.

Sorghum Downy Mildew (fungus - Peronosclerospora sorghi): Infected plants are stunted and yellow in the seedling stage with stripes or streaks in the leaf tissue. Spores are produced on the lower surface of affected leaves opposite the lighter striped areas. This may have the appearance of "down" especially during early morning hours. Soil-borne spores cause infection of the young seedlings. These systemically infected plants will not produce heads. Plants may become infected later but this is less common than seedling infection. Grain sorghum hybrids vary considerably in their susceptibility. Growers should select adapted, high producing hybrids that have resistance to this fungus. Growing highly susceptible grain or forage sorghum builds up populations of the organism in soil, making the problem more severe even in resistant hybrids. Deep plowing sorghum crop residue has decreased infection in the following crop as much as 50 percent. Use seed treated with a systemic fungicide and resistant hybrids to control this disease.

Crazy Top Downy Mildew (fungus - Sclerophthora macrospora): This fungal disease can be troublesome in low lying areas that become flooded. Wild and cultivated grasses can serve as sources of inoculum. There are differences in susceptibility among grain sorghum hybrids but these differences are not great. Installing drainage structures and diverting water movement to avoid flooding is the most reasonable suggestion for control at this time.

Maize Dwarf Mosaic Virus (MDMV): This virus disease occurs over all the sorghum producing areas of Texas. Its ability to cause damage is dependent on the presence of an overwintering virus host (mainly Johnsongrass), aphid populations to facilitate virus transmission and the susceptibility of the hybrid being grown. Affected plants have mottled terminal leaves. These alternate light and green areas in the leaf can be more easily seen when held between the viewer and a light source. Observers should always look at the newest leaves for the most severe symptoms. Highly susceptible hybrids are stunted with chlorotic symptoms in the upper leaves. Some hybrids produce a red leaf symptom when plants are infected and when night temperatures are below 55°F. Use tolerant hybrids and control Johnsongrass in and around the field. Consult the Sorghum Diseases Atlas for color illustrations of symptoms and information on disease development.

Head Smut (fungus - Sporisorium reilianum): This disease is typified by the large smut galls that emerge at heading time. The gall is first covered with a whitish membrane which soon breaks and allows spores to be scattered by the wind. Plants become infected while in the seedling stage but evidence of infection is not apparent until heading time. The smut gall produces thousands of spores that initiate infection in subsequent years. Races of the fungus are known which can infect so-called resistant sorghum lines. New sources of resistance have been found and growers should utilize resistant hybrids to avoid losses from this disease.

Covered Kernel Smut (fungus - Sporisorium sorghi): This smut disease was once quite destructive but is seldom seen now because most seed is chemically treated. The disease destroys all kernels in a head and replaces them with a cone-shaped gall. At harvest time, these galls are broken and spores contaminate the outer surface of other kernels. This disease is controlled by use of chemical seed treatment, use of clean seed and planting resistant hybrids.

Loose Kernel Smut (fungus - Sporisorium cruenta): Galls formed by loose kernel smut are long and pointed and the thin membrane covering them usually breaks soon after galls reach full size. This disease presents no immediate problem because the control measures mentioned for covered kernel smut have virtually eliminated occurrence of this disease.

Foliage Diseases Caused by Fungi: A number of fungal organisms cause foliage infection and may become severe under certain conditions. Occurrence has never been consistent or damaging enough to warrant the development of specific control practices. No fungicides have been cleared for use on sorghum foliage and there is no likelihood of such unless occurrence pattern changes. Hybrids vary in their susceptibility to these diseases and resistance is available if their occurrence becomes a problem. The following information will aid in the identification of specific foliage diseases.

Name	Pathogen	Symptom
Leaf Blight	Exserohilum turcicum	Large elongated spots with gray centers and tan-to-reddish borders.
Target leaf spot	Drechslera sorghicola	Round-to-elliptical spots with reddish purple centers and tan margins.
Anthracnose	Colletotrichum graminicola	Elliptical-shaped spots that are 1/8"-7/8" in diameter. Tan-to-red with distinct margins.
Gray leaf spot	Cercospora sorghi	Dark purple spots having a grayish cast when pathogen is producing spores. Elongate to round, 1/4" and larger.

Zonate leaf spot	Gleocercospora sorghi	Large, irregular-shaped spots having a bullseye appearance.
Rough leaf spot	Ascochyta sorghina	Grayish spots that are rough to the touch because of raised black fruiting bodies.
Sooty stripe	Ramulispora sorghi	Elongate spots having a sooty nature because of sclerotia.

Bacterial Stripe (bacterium - *Pseudomonas andropogoni*): This is the most common bacterial disease of sorghum. The disease is characterized by long narrow stripes that vary from red to black depending on the type of sorghum. These stripes are confined between the veins and may have a crusty surface when the bacterial slime dries on the surface. This disease has not constituted a serious problem sufficient to warrant specific control.

Bacterial Streak (bacterium - *Xanthomonas holcicola*): Streak first appears as dark green watersoaked tissue between veins that later turns brown with red margins. Control measures have not been warranted.

Bacterial Spot (bacterium - *Pseudomonas syringae*): Spots first appear on lower leaves and infection spreads to upper leaves. Spots first appear as watersoaked green spots, later turning tan with red borders. Small lesions are often red throughout. Control measures are not usually necessary.

Anthracnose (fungus - *Colletotrichum graminicola*): Grain sorghum is one of several hosts of the anthracnose fungus. This organism penetrates the leaf surface and develops lesions that are circular-to-oval and may be up to one inch in diameter. Spots are tan-to-reddish depending on susceptibility of the host. Mature lesions have distinct margins with sunken, darkened centers. Foliar damage is not considered as damaging as the stalk rot phase. (See stalk rots.)

Rust (fungus - *Puccinia purpurea*): Rust appears on leaves as raised pustules or blisters covered with a brown coating that ruptures and releases the chestnut-brown spores. These pustules occur on both the upper and lower leaf surfaces. This disease usually appears when plants near maturity and infection is confined primarily to mature leaves. Grain yield losses are usually not serious and occurrence of the disease is sporadic. Forage sorghum yields may be affected most. The rust fungus also attacks Johnsongrass and overwinters on this host in southern production areas.

Charcoal Rot (fungus - *Macrophomina phaseolina*): Grain sorghum plants affected by the charcoal rot fungus fail to fill grain properly and may lodge in the latter part of the season. Infected stalks show a shredded condition at and above the ground line. This can be observed by splitting the stalk and noting the deteriorated pith tissue. Fungal structures (sclerotia) can be observed in the affected tissue which appears as though it has been dusted with black pepper. Another type of stalk rot (*Pythium* sp. and Fusarium sp.) may show the shredded condition but the black specks (sclerotia) will be lacking. Conditions under which charcoal rot occurs have been documented. Soil temperatures must be in excess of 95°F and the soil must contain less than 80 percent available moisture for four days. Host plants must be in the early-milk to late-dough stage for infection too occur. The fungus must be present but it is widely distributed in nature. Avoiding moisture stress, proper management of crop residue and crop rotation represent the best means of control.

Red Stalk Rot (fungus - *Colletotrichum graminicola*): This is the stalk rot phase of the anthracnose disease. It can best be diagnosed by splitting the upper portion of stalk to see if the pith area is noticeably discolored in a spotted or ringed pattern. Stalk infection results in lodging that makes harvest more difficult. Losses are proportionate to the extent of infection, susceptibility of the hybrid, stage of growth when infected and the length of time between infection and harvest. Avoid growing highly susceptible hybrids in areas where this disease is most destructive.

Fusarium Stalk Rot (fungus - *Fusarium moniliforme*): Like charcoal rot, Fusarium stalk rot usually develops on mature to nearly mature plants that have been subjected to some form of stress. Infection takes place at the base of the plant and produces discoloration in the stalk. When shredding of the vascular area occurs from this organism, black fungal bodies (sclerotia) are not present as they are with charcoal rot. Avoiding stress problems by proper use of cultural practices is the best approach to control.

Root Rot Complex (fungi - *Fusarium moniliforme*, *Pythium* sp. and others): Several fungi are involved in producing the root rot condition of grain sorghum. One or more of the causal fungi may be involved depending on conditions and organisms present in the soil. Each organism produces distinct symptoms, but identification becomes more complex when other factors are involved. Rotation with non-related crops will lower the population of pathogenic organisms present in the soil.

DISEASE RATINGS OF COMMERCIAL FORAGE SORGHUM HYBRIDS

Company/Hybrid	Downy Mildew systemic	Downy Mildew foliar	Maize Dwarf Mosaic
1. Anton Master Graze DR (Warner)	Resistant	Moderately susceptible	Tolerant
2. Anton Su Sweetie Graze (Warner)	Resistant	Moderately susceptible	Tolerant
3. Asgrow Beefbuilder TD	Very resistant	Resistant	Intermediate
4. Asgrow Grazer M	Very resistant	Resistant	Susceptible
5. Conlee Cow Vittles	Moderately	Resistant	Intermediate
6. Conlee Dine-A-Mite	Resistant	Susceptible	Tolerant
7. Conlee Do-Mor	Resistant	Resistant	Tolerant
8. Conlee Hay Smak	Moderately resistant	Susceptible	Intermediate
9. Conlee Mor Gain	Susceptible	Moderately susceptible	Tolerant
10. DeKalb SX-17+	Resistant	Moderately resistant	Intermediate
11. Funk G-88F	Resistant	Resistant	Intermediate
12. Funk G-98	Moderately resistant	Resistant	Intermediate
13. Funk G-102S	Resistant	Very resistant	Intermediate
14. Funk HW-5111-815-F	Very resistant	Resistant	Susceptible
15. Growers 30F	Resistant	Resistant	Susceptible
16. Growers 1586F	Resistant	Moderately resistant	Susceptible
17. Horizon F-12	Moderately resistant	Moderately resistant	Susceptible
18. Horizon SP-110	Moderately resistant	Moderately resistant	Susceptible

Company/Hybrid	Downy Mildew systemic	Downy Mildew foliar	Maize Dwarf Mosaic
19. Horizon Kafir Dan	Susceptible	Resistant	Susceptible
20. King K-100	Resistant	Resistant	Intermediate
21. King 61	Moderately susceptible	Moderately susceptible	Tolerant
22. King 61 DR	Resistant	Moderately resistant	Very tolerant
23. King Sugar Red	Moderately resistant	Resistant	Susceptible
24. King Silo King	Susceptible	Resistant	Intermediate
25. King Sugar Sweet	Susceptible	Susceptible	Tolerant
26. King Sugar TRU	Resistant	Moderately resistant	Susceptible
27. NK 300	Moderately susceptible	Moderately susceptible	Intermediate
28. NK 326	Resistant	Resistant	Intermediate
29. NK 367	Moderately resistant	Very resistant	Intermediate
30. NK Millex 24	Very resistant	Very resistant	Very tolerant
31. NK Silo Milo 3	Resistant	Resistant	Intermediate
32. NK Sordan 79	Very resistant	Moderately resistant	Tolerant
33. NK Trudan 8	Resistant	Susceptible	Intermediate
34. NK X-7984-F	Very resistant	Very resistant	Susceptible
35. NK X-8042-F	Resistant	Resistant	Intermediate
36. Pioneer 911	Susceptible	Moderately susceptible	Intermediate
37. Pioneer 923	Susceptible	Resistant	Intermediate
38. Pioneer 931	Susceptible	Resistant	Intermediate
39. Pioneer 947	Moderately resistant	Very resistant	Susceptible

Company/Hybrid	Downy Mildew systemic	Downy Mildew foliar	Maize Dwarf Mosaic
40. Pioneer 956	Moderately susceptible	Moderately resistant	Susceptible
41. Pioneer 988	Moderately susceptible	Susceptible	Intermediate
42. Pioneer 989	Moderately susceptible	Susceptible	Intermediate
43. Richardson Bundle King II	Moderately resistant	Resistant	Susceptible
44. Richardson Silo Master	Moderately resistant	Resistant	Intermediate
45. Richardson Sugar Red	Moderately resistant	Moderately resistant	Susceptible
46. Richardson Sugar Su	Susceptible	Susceptible	Susceptible
47. Richardson Sugar Su-D	Moderately susceptible	Moderately resistant	Tolerant
48. Richardson R79Fa	Moderately susceptible	Moderately resistant	Intermediate
49. Richardson R79Fx	Susceptible	Susceptible	Tolerant
50. Taylor-Evans Goldmaker	Moderately resistant	Resistant	Susceptible
51. Taylor-Evans Goldmaker-T	Moderately resistant	Very resistant	Susceptible
52. Taylor-Evans Haygrazer	Moderately resistant	Susceptible	Tolerant
53. Taylor-Evans Haygrazer-II	Resistant	Moderately susceptible	Tolerant
54. Taylor-Evans Haygrazer-T	Moderately susceptible	Moderately resistant	Intermediate
55. Taylor-Evans Milkmaster	Resistant	Resistant	Intermediate
56. Taylor-Evans Milkmaker-T	Resistant	Very resistant	Intermediate
57. Taylor-Evans Silomaker	Moderately susceptible	Moderately resistant	Intermediate

Company/Hybrid	Downy Mildew systemic	Downy Mildew foliar	Maize Dwarf Mosaic
58. Taylor-Evans Yieldmaker	Susceptible	Moderately resistant	Tolerant
59. Texas Triumph Bet-R-Sile	Moderately resistant	Resistant	Intermediate
60. Warner Gro-N-Graze DR (wht)	Resistant	Resistant	Tolerant
61. Warner 2-Way	Resistant	Resistant	Intermediate
62. Warner Sucrosse S-1	Susceptible	Moderately susceptible	Susceptible
63. Warner Sucrosse 2-S	Moderately susceptible	Moderately susceptible	Intermediate
64. Warner Sweet Bee (fertile)	Moderately resistant	Moderately susceptible	Intermediate
65. Warner Sweet Bee (sterile)	Susceptible	Moderately resistant	Susceptible
66. Warner Sooper-Su	Resistant	Moderately resistant	Intermediate
67. Warner Gro-N-Grazer GTR-1	Resistant	Moderately susceptible	Tolerant
68. Warner Circle W-R	Moderately susceptible	Moderately susceptible	Tolerant
69. Warner Circle W-W	Moderately susceptible	Susceptible	Intermediate
70. Warner Gro-N-Graze DR (red)	Resistant	Moderately resistant	Tolerant
71. Warner Gro-N-Graze PTR-1	Moderately resistant	Susceptible	Susceptible
72. Warner Gro-N-Graze (Okla.)	Moderately susceptible	Susceptible	Susceptible
73. Warner 2-Way-A	Moderately susceptible	Resistant	Intermediate
74. Warner 2-Way-Dr	Very resistant	Very resistant	Intermediate
75. Warner 2-Way-T	Moderately susceptible	Very resistant	Intermediate

Company/Hybrid	Downy Mildew systemic	Downy Mildew foliar	Maize Dwarf Mosaic
76. Warner Sooper-Su (wht)	Moderately susceptible	Susceptible	Susceptible
77. Warner Sooper-Su A (wht)	Susceptible	Susceptible	Susceptible
78. WAC-Seedtec Hi-Energy	Moderately resistant	Very resistant	Susceptible
79. WAC-Seedtec Hi-Ton	Moderately resistant	Resistant	Susceptible
80. WAC-Seedtec Sic-um	Moderately resistant	Moderately resistant	Intermediate
81. Young Red Top Kandy	Susceptible	Moderately resistant	Intermediate
82. Young RTK XTRA	Resistant	Resistant	Intermediate

RICE

Oryza sativa

Seedling Blight and Seed Decay (fungi - *Bipolaris oryzae*, *Pythium* sp., *Rhizoctonia solani*, *Achlya* sp. and *Sclerotium rolfsii*): Seedling diseases cause spotty, irregular stands through seed decay, pre-emergence and post emergence disease. Seedling disease complex results from activity of various kinds of fungi, most of which grow on kernels or hulls of seed rice or on soil organic matter. Fungi enter germinating rice seed or young seedlings and either injure or kill them. If infected seedlings emerge from the soil, they are likely to die. Those that manage to survive are weakened and chlorotic in appearance. Damage is most severe on early seeded rice (late February and March) and deeply planted rice. Control measures include the use of high quality planting seed, an approved seed treatment and shallow seeding of early planted rice.

Sheath Blight (fungus - *Rhizoctonia solani*): Sheath blight is rapidly becoming the most important disease of rice in Texas. Initial symptoms usually develop as lesions on sheaths of lower leaves near the water line when plants are in the late tillering or early internode elongation stage of growth (approximately 10 - 15 days after flooding). These lesions develop just below the leaf collar as circular-to-ellipsoid green-gray, water-soaked spots about one-fourth inch wide and one-half to one inch long. With age, the center of the lesion becomes bleached with an irregular tan-to-brown border. When humidity exceeds 95 percent and temperatures are in the range of 85-90^{O}F, infection spreads rapidly by means of runner hyphae to upper plant parts including leaf blades. Disease development is most rapid in the early heading and grain filling growth stages during periods of prolonged rainfall. Plants heavily infected at these stages produce poorly filled grain, particularly in the lower portion of the panicle. Additional losses result from increased lodging or reduced ratoon production due to death of the culm.

As plant senesce from maturity or plant death, lesions will dry and become white or tan with brown borders. Sclerotia, initially white but turning dark brown at maturity are produced superficially on or near the lesions. Sclerotia are loosely attached and easily dislodge from the plant. Sclerotia are the primary means for fungus survival between crops. They survive long periods in the soil and will float to the surface of flooded rice fields in the following year and infect rice plants at the waterline to continue the disease cycle. Sclerotia can survive for one to two years in the soil.

New varieties and changing cultural practices often combine many of the factors that favor disease development. In recent years, the wide acceptance of susceptible varieties, because of their high yielding potential, has contributed greatly to the rapid increase in sheath blight. In addition, the new varieties respond to heavy nitrogen applications in order to achieve their high yielding potential. Heavy applications of nitrogen predispose susceptible plants to attack by the sheath blight organism. Rotation with susceptible crops, such as soybean (see Soybean Aerial Blight) can also increase the severity of sheath blight in succeeding rice crops.

Disease incidence may be reduced by planting less susceptible varieties (see Table on reaction of rice varieties to major diseases). None of the long grain varieties currently grown in Texas show adequate field resistance. Excess seeding rates and high nitrogen applications should be avoided in fields with a history of the disease. Grass and weeds should be controlled. Foliar fungicides are effective in reducing losses from this disease. Long-term rotations may reduce the incidence of sheath blight, but both soybeans and sorghum are susceptible to Rhizoctonia solani.

Stem Rot (fungus - Sclerotium oryzae): Stem rot becomes most noticeable in rice fields during the latter stages of maturity. The disease occurs in circular to irregular areas in fields and causes death of the plants. The fungus attacks the rice plant near the water line, first causing black watersoaked areas on the sheath which are rectangular in shape but later turn irregular. As rice approaches maturity, injury on stems increases and reaches its peak at harvest. Stalks break during this stage and plants lodge making harvest difficult. Plants infected early yield poorly. Stubble cropping in many areas is impractical because of the high percentage of plants killed by the disease. Diagnosis is made by obtaining an infected plant and spitting the base of the stem. Presence of small, black sclerotia in internal stem tissues is an effective means of diagnosing the disease. Control measures include the following: crop rotation, water management and lower rates of nitrogen applications in fields with a history of stem rot. Currently available fungicides do not effectively reduce this disease.

Blast (fungus - Pyricularia oryzae): This disease, which is also called rotten neck, can cause serious losses. The fungus produces spots or lesions on leaves, nodes and panicles. Infection may also appear at the place where the leaf blade joins the sheath. Leaf spots are elliptical and rather long with more or less pointed ends. The center of the spot is usually gray and the margin brown or reddish-brown. Both the shape and color of the spots may vary and resemble those of the brown leaf spot disease. Blast differs from brown leaf spot in that it causes longer lesions and develops more rapidly. The blast fungus frequently attacks the panicle and branches of the head. If the panicle is attacked early in its development, the grain on the lower portion of the panicle will be blank giving the head a silvery or white color, thus the term "blasted" head or rice "blast". If the node at the base of the panicle is infected, the panicle breaks causing the "rotten neck" condition. In addition, the fungus may also attack the nodes or joints of the stem. When a node is infected, the sheath tissue rots and the part of the stem above the point of infection is killed. In many instances, the node is weakened to the extent that the stem will break causing extensive lodging. If infection occurs early and is severe, the plant is stunted and loses nearly all its leaves, or the whole plant (including tillers) can be killed.

Blast generally occurs scattered throughout a field rather than in a localized area of the field. Late planting, rain and warm weather favor development of blast. Spores of the fungus can be airborne and are generally carried downwind. High nitrogen fertilization should be avoided in areas that have a history of blast. Control measures include early planting, lowering of nitrogen applications in fields with a history of blast, and proper flood management. Varietal resistance is the most effective method of controlling rice blast. See table at the end of this section for the reactions of currently grown rice varieties to the blast fungus. Foliar fungicides can reduce the incidence of blast but severe losses can occur on susceptible varieties even when fungicides are applied.

Brown Leaf Spot (fungus - Bipolaris oryzae): This disease is the most prevalent rice disease occurring in Texas. Most conspicuous symptoms of the disease occur on leaves and glumes of maturing plants. Symptoms also appear on young seedlings and the panicle branches in older plants. Brown leaf spot is a seed-borne disease. Leaf spots may be evident shortly after seedling emergence and continue to develop until maturity. Typical leaf spots are circular to oval in shape with dark-brown margins surrounding a grayish center. Spots vary in size, but are typically 1/8" in diameter. Damage from brown spot is particularly noticeable when the crop is produced in nutritionally deficient or otherwise unfavorable soil conditions. Brown spot may be reduced by balanced fertilization, crop rotation, and the use of high quality planting seed. Foliar fungicides are not economical for controlling brown leaf spot on most commercial long grain varieties.

Narrow Brown Leaf Spot (fungus - Cercospora oryzae): Prevalent in the eastern portion of the Texas Rice Belt. Disease varies in severity from year to year and usually becomes most severe as rice approaches maturity. Leaf spots are long, narrow, and cinnamon-brown. Premature leaf death will occur in severe cases. The fungus can also attack the flag leaf sheath and uppermost internode of the rice plant causing the brown blotch phase of the disease. This generally occurs late in the growing season. Diseased areas are reddish-brown, usually 2 - 3 inches long and typically encircle the uppermost internode an inch or so below the the base of the panicle. Early maturing varieties tend to escape the disease. There is partial resistance in some varieties; however, due to buildup of certain races of the fungus, resistant varieties may be attacked by the disease. Foliar fungicides effectively control this disease and may be economical on some varieties in certain years.

Kernel Smut (fungus - Neovossia horrida): This disease causes losses in both yield and quality. Endosperm of the grain is attacked by the fungus causing either a part or all of the starchy material to be replaced by a black mass of smut spores. The fungus does not destroy the embryo and the diseased seed will germinate even if all the endosperm has been replaced. Release of the smut spores from within the kernel will cause a discoloration of hulls. Moisture causes the dark mass of spores to swell and break out of the hull. Smut is easily detected after a rain or in the early morning following a heavy dew. Kernel smut is usually most severe on late planted rice. Although only a small percent of the kernels are affected, monetary losses are greater because of penalties levied on the grain at the dryer. High rates of nitrogen increase the incidence of smut as do excessive water depths. Varieties differ in the incidence of smut observed in commercial plantings. Labelle and Skybonnet appear to be the varieties in which smut is most frequently detected. Less smut is detected in commercial semi-dwarf varieties. Control measures include the use of semi-dwarf varieties in fields with a history of smut and to reduce nitrogen rates and floodwater depths in fields where very susceptible varieties must be grown.

Kernel Spots: Rice grain may be infected by several fungal organisms before harvest causing discoloration, the severity of which varies according to season. Discoloration may appear internally on grain or externally on glumes, or both. Kernel spotting increases during periods of high humidity and on late maturing or second crop rice. Injury to the developing kernel, either from stink bugs or mechanical injury, will predispose the kernel to fungal infection. Kernel spots reduce grade and yield of head rice. No control measures other than insect control are recommended.

Sheath Spot (fungus - Rhizoctonia oryzae): This disease is similar to the early stages of sheath blight and is caused by a related fungus. Pink-to-salmon-colored sclerotia initiate the disease on the outermost leaf sheath. A reddish-brown lesion develops on the plant near the waterline. During internode elongation, the sheath spot may be pushed up above the waterline because of this new growth. With age, the lesion enlarges slightly to assume an eliptical to irregular shape (1/2 to 1 inch long) with a distinct purple-brown border and a tan-to-straw colored center. The sheath spot fungus does not develop on the leaf blades as is the case with sheath blight. Rather it remains on the outer sheath only. Sometimes the fungus will cause a yellowing of the leaf attached to the sheath it has infected. Some reduction in yield may occur in tillers that are infected; however, it is generally minor and too few tillers are affected to result in a significant yield loss.

Leaf Scald (fungus - Gerlachia oryzae): This disease usually occurs on maturing leaves. Lesions may stunt at the tips or anywhere along the leaf margin. The lesions are usually tan-to-brown with a gold colored margin. Lesions beginning at the margin of leaves are generally "half-circle" in shape and about 1" in diameter. Some reduction in yield may occur when flag leaves are severely infected but generally damage is light and no control measures are recommended.

Leaf Smut (fungus - Entyloma oryzae): This is a minor fungal disease in which small slightly raised black spots develop primarily on the leaves. Raised spots or pustules break open releasing air-borne spores. Infection is often heavy enough to kill tips of leaves. Leaf smut occurs late in the growing season and causes little or no economic loss. No control measures are recommended.

Straighthead (physiological disorder): Straighthead is a physiological disorder that causes the entire head to be blank and remain upright at maturity. Straighthead generally occurs in spots scattered throughout a field and is most easily recognized near harvest when normal plants have downturned heads (from the weight of the grain in the panicle). The disease is frequently found on sandy loam soils but seldom on clay soils. Old cotton fields with arsenic residues can have a severe incidence of straighthead. Other, as yet unknown, soil factors are also involved in causing straighthead. Often it is found in fields where excessive non-decayed vegetation has been plowed under just before planting.

The disease is characterized by upright heads when the rice matures due to infertile seed. Hulls may be distorted into a crescent shape or "parrot beak". One or both hulls may be missing. Affected plants continue to grow, are a darker green, and often produce shoots from a lower portion of the plant. First year crops of rice grown on "new ground" are more likely to be affected. Some varieties are more tolerant than others. Control measures include planting resistant varieties and draining fields with a history of the disorder just prior to internode elongation.

White Tip (nematode - Aphelenchoides besseyi): This disease is caused by a plant parasitic nematode. The nematode attacks leaves, sheath and head. Tips of affected leaves turn white and later become dark and frayed. Symptoms are most conspicuous on the flag leaf causing the leaf blade and sheath to twist so that the head is held in the boot. Severely affected plants have stunted heads that produce little or no grain. If grain is produced it is abnormal in shape. The nematode causing white tip is carried on seed. Nematodes remain dormant during winter months. When the seed is planted, the nematode becomes active and moves into the growing point of young rice plants where they feed and multiply. During blooming, nematodes move inside the flower where they remain until the grain matures. White tips can be controlled by growing resistant varieties and planting disease-free seed.

Alkalinity or Salinity: Injury is characterized by stunted, yellow areas in the field. These areas vary in size from a few to several hundred feet in diameter. Affected areas have dead or dying rice in the center followed by dwarfed and yellowing rice toward the periphery. Injury generally occurs in the seedling stage and may be confused with seedling blight. A knowledge of the field history and pattern in which the problem occurs will enable one to distinguish it from common seedling disease. Damage from this problem may be reduced by avoiding the use of water with high salt content or high pH. If the problem exists in a field, alternate flushing until plants are in the tiller stage often alleviates the problem.

Reaction of Long-grain Rice Varieties to Current Races of the Rice Blast Fungus (Pyricularia oryzae).

Variety	US-1	US-2	US-3	US-13	US-16	US-35	US-36
Bellemont	MS	R	MS	MS	MS	MS	MS
Gulfmont	R	R	R	R	MR	MR	R
Labelle	R	R	R	R	MR	MR	R
Lebonnet	R	R	R	R	MR	MR	R
Skybonnet	R	R	R	R	MR	MR	R
Lemont	R	R	R	R	MR	MS	R
Rexmont	MS	R	MS	MS	MS	MS	MS
Newbonnet	R	R	R	S	VS	VS	R
Tebonnet	R	R	MS	S	MS	S	MS

R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible. Reactions based on blast nursery screening trials where varieties are inoculated with isolates of individual races. Currently, races US-16 and US-35 are the most frequently recovered in south and central U.S.

Disease Reaction of Currently Grown Long-grain Rice
Varieties as Assessed in Commercial Fields in the Texas Rice Belt

Variety	Sheath Blight	Stem Rot	Brown Leaf Spot	Narrow Brown Leaf Spot	Rice Blast	Kernel Smut	Straighthead
Gulfmont	VS	S	R	MS	R	MR	MR
Labelle	S	S	MS	MS	R	S	R
Lebonnet	VS	VS	MR	S	R	MS	MR
Lemont	VS	S	MS	S	R	MR	MR
Newbonnet	MS	S	MS	MS	S	S	MR
Rexmont	VS	S	R	MR	MS	MR	MR
Skybonnet	VS	S	S	MS	R	S	MS
Starbonnet	VS	S	S	S	MS	S	MR
Tebonnet	MS	S	MR	MS	MS	-	S

R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible. Varieties rated S or VS for a given disease or disorder may allow extensive disease development under favorable environmental conditions. Varieties rated R or MR show less or no damage under similar conditions.

RYE

Diseases occurring on rye are very similar to those on wheat and barley. (See wheat and barley for disease symptoms and control.)

WHEAT

Triticum aestivum

Leaf Rust (fungus - *Puccinia recondita*): Leaf rust occurs on either side of the leaf and on the leaf sheath as small, reddish-orange pustules. In most years, leaf rust causes more damage in Texas than any other wheat disease. It causes a reduction in the number and size of kernels. The disease reduces forage production in fields where it is utilized for grazing. New races of the rust fungus originate naturally and challenge new wheat varieties to resist existing races. The leaf rust fungus of wheat does not attack oats or barley.

Stem Rust (fungus *Puccinia graminis* f. sp. *tritici*): Stem rust is recognized by the elongated, ragged pustules it produces on stem, leaf sheath, blade, chaff, beard and occasionally on young kernels. Fragments of epidermis adhere to the sides and ends of the pustules, giving a ragged appearance. The brick-red color and large elongated pustules distinguish it from leaf rust which has small round pustules and orange-red spores. Stem rust is far more devastating than leaf rust on susceptible varieties. Soft wheat varieties are generally more susceptible than hard red winter wheat varieties.

Stripe Rust (fungus - *Puccinia striiformis*): Stripe rust resembles leaf rust except the pustules develop along the leaf veins as long streaks. Mild winters followed by very cool springs and abundant rainfall permit this disease to increase. It is generally not an important disease, but may be locally severe.

Loose Smut (fungus - *Ustilago tritici*): Loose smut destroys the grain and all glume structures of the spike leaving only the central rachis. Infected plants which head early, produce smut spores that are wind-borne to healthy plants at flowering time. Spores germinate and germ tubes penetrate the young wheat ovaries where the fungus remain dormant until those seed germinate. Use of systemic seed treatment fungicides and disease-free seed will prevent this disease.

Stinking Smut or Bunt (fungus - *Tilletia foetida*): Heads affected by stinking smut fungus have a distinct blue cast. At bloom time infected heads are more slender than healthy heads and do not put out pollen sacks. At maturity they appear plumper but lighter in weight than normal heads. The smut ball consists of a mass of oily, foul-smelling, dark-brown powder (spores of the stinking smut fungus). In the field, smutted heads usually stand more nearly erect than healthy heads because of their lighter weight. In some varieties, it is necessary to crush the kernels to determine if heads are diseased. The offensive odor indicates the presence of heavy infections either in fields or in shipped grain. Infested wheat is usually condemned before shipment.

While smut balls may be removed by cleaning and recleaning seed, spores will still be carried on kernels. Chemical seed treatment should be used to control spores on seed.

Leaf Blotch (fungus - *Septoria tritici*): Lesions appear as pale green to yellow spots on the leaf. As cells in the spot are killed it turns brown.

Later, gray to black fruiting bodies are formed in the dead spot. Treat seed with a fungicide and rotate wheat with unrelated crops.

Glume Blotch (fungus - Septoria nodorum): Glume blotch occurs on the glumes, nodes, spikes, and glumes causing blackened areas. Stems are weakened and may bend or break just above the nodes. Seed may be shriveled, reducing yields and quality of grain. Seed treatment, rotation and deep burial of crop residue will reduce disease losses.

Powdery Mildew (fungus - Erysiphe graminis f. sp. tritici): Powdery mildew is usually found only on the leaves, but the fungus may attack all aboveground parts of the plant. It is noticeable first as small, irregular or circular, light gray spots on the upper surface of a leaf. The spots enlarge as the fungus grows and often may involve large parts of the leaf. As the spots age, the fungus on them takes on a flowery appearance which is due to the production of an enormous number of spores. Often the lower surface of the leaf beneath the diseased spots turns yellow and older parts of the spots turn brown. Affected leaves become deformed and crinkled and in severe cases they become brittle or they may die prematurely. As affected wheat approaches maturity, small, black fruiting structures (seen as black specks) may be scattered throughout the fungus growth on infected spots. This disease is not seed-borne but can be soil-borne. Close grazing to keep top growth reduced to a minimum will allow sunlight and air to keep the crown of the plant dried out, thus reducing the occurrence of powdery mildew. Rotations with non-host plants will also help reduce the soil-borne phase of this disease. Chemical control may be economical on high yield potential wheat.

Common (dry land) Root Rot (fungus - Bipolaris sorokiniana): The fungus infects the sub-crown internode of young wheat seedlings. Root rotting can continue throughout the season and is most severe when new root formation is slowed. Later in the season, drought and warm temperatures favor root rot. Seed treatment and balanced fertility programs can reduce disease severity. Crop rotation may also reduce the disease. Common root rot is widely distributed in Texas.

Foot Rot (fungi - Fusarium avenaccum, Fusarium spp.): Foot rot generally begins as an invasion of seedling roots. Foot rots are favored by cool temperatures. The fungus is more a secondary invader of roots initially infected by the common root rot fungus. The fungus surviving on crop residues and rotation may reduce disease severity.

Take All (fungus- Gaeumannomyces graminis var. tritici): Take-all is most obvious near heading on plants growing in moist soil. Diseased plants have basal internodes that are shiny black and have few tillers. Heads ripen prematurely and are bleached (white-heads) and sterile. Plants may break free at the crown when pulled from soil. The fungus causing take-all persists in infected wheat stubble. Take-all is favored by alkaline, compacted, infertile (esp. nitrogen and phosphorus-deficient) and poorly drained soils. The disease has only been observed in Texas under irrigated conditions on the High Plains and Rolling Plains. Rotation may reduce disease incidence in fields where take-all has been a problem.

Rhizoctonia Root Rot and Sharp Eyespot (fungus- Rhizoctonia solani): Many Rhizoctonia strains infect wheat roots and culms. Culm infections are sometimes observed in North Central and East Texas. These are referred to as sharp eyespot. Sharp eyespot begins as a gray colored lesion on the lower leaf sheath. Lesions may later turn straw colored. Acid, sandy and dry soils increase disease risk as do cool spring temperatures.

Bare Patch of wheat is also caused by a particular strain of Rhizoctonia solani. This disease has not yet been identified in Texas.

Tan Spot (fungus - Pyrenophora trichostoma): Tan spots can occur on both leaf surfaces. Initial symptoms will be tan-brown flecks and the spots will enlarge into lens-shaped lesions. The fungus grows as a saprophyte on crop residue. Because of this it has been observed to be more severe in no-till wheat. Cultural practices such as deep burial of straw and rotation will help reduce tan spot. Fungicides may be economical if the crop has a potential yield of forty bushels or more per acre.

Wheat Streak Mosaic Virus: The vector of this virus is a microscopic eight-legged, cigar-shaped, wheat curl mite Aceria tulipae. This disease is more severe in the High Plains area of Texas. Although most severe infection occurs in the fall, the characteristic yellowish streaking and mottling of leaves usually are first observed after warmer spring weather. As plants approach maturity, the leaves turn brown and die. Control for this disease is possible by clean tillage around fields, early destruction of volunteer wheat and late planting after frost.

Yellow Dwarf Virus: New growth of wheat plants infected in the seedling stage is chlorotic or yellowish in color. The entire plant will be severely dwarfed, tiller sparsely and produce few heads with little or no seed. Plants that become infected after the tillering stage are not dwarfed. The yellow dwarf virus can be carried from plant to plant by several species of grain aphids that overwinter on perennial grasses. No effective control measures are known other than utilizing tolerant varieties.

Soil-borne Mosaic (virus): Symptoms of soil-borne mosaic appear early in the spring, usually when weather is cool and damp, but are rarely seen in fall or winter. Fields observed from a distance have irregular patches of light green or yellow plants. Symptoms on plant leaves range from mild green to yellow mottling and striping, giving the mosaic appearance.

Stunting varies from moderate to severe and may be accomplished by rosetting. Symptom expression favors temperatures below 68° F. and gradually disappear before harvest time if normal temperature persists.

A soil-borne fungus, Polymyxa graminis, which is a parasite of roots of many grass plants, is the vector of this disease. Virus particles are either inside spores of the fungus or are attached to the spores. The fungus invades the roots in the fall, when soils are cool and wet, carrying the virus particles with it.

There is no practical way to rid the soil of the soil-borne mosaic virus. Rotation out of wheat to other crops will reduce losses.

Nematodes: (See discussions in section on Barley.)

HARD RED WINTER WHEAT

Variety a/	Leaf Rust	Stem Rust	Powdery Mildew	Septoria	Best b/ Production Area
Arkan[1]	MR	MR	MS	S	2,3,4,6
Bounty 100[2]	S	-	MS	S	1,2,7
Bounty 122[2]	MS	MR	S	MS	1,2,3,6
Bounty 201[2]	S	MS	MS	S	1,2,7
Bounty 202[2]	S	MS	MS	S	1,2,7
Bounty 203[2]	S	-	MS	S	1,2,7
Bounty 205[2]	S	MR	MS	S	1,2,7
Bounty 301[2]	R	-	S	MS	1,2,7
Century[1]	R	MS	R	MS	1,2,3,4,6
Chisholm[1]	S	S	S	S	2
Collin[1]	MR	MR	MR	MS	3,4,5,6
Hawk[2]	S	MR	S	S	1,2,7
HR 48[2]	S	MS	S	S	1,2,7
HR 64[2]	S	S	S	MS	1,2,7
HW 1010[2]	S	-	MS	S	1,2,7
HW 1030[1]	S	-	MS	S	1,2,7
HW 1031[2]	S	-	S	S	1,2,7
HW 1035[2]	S	-	MS	S	1,2,7
HW 1037[2]	S	-	MR	S	1,2,7
Milburn[2]	MR	MR	R	MS	2,3,4,6
Mit[1]	MR	MS	MS	MS	3,4,5,6
Mustang[2]	S	MS	S	S	1,2,7
NK Pro 812[2]	S	S	S	S	2
Payne[1]	MR	MS	S	S	2,3,6

Variety a/	Leaf Rust	Stem Rust	Powdery Mildew	Septoria	Best b/ Production Area
Pioneer 2157[2]	MS	S	S	MS	2,3,6
Pioneer 2165[2]	MS	S	MS	MS	2,3,6
Pony[2]	R	-	MS	S	1,2,3,6
Quantum 588[2]	S	-	MS	MS	1,2,7
Rodeo[2]	S	-	MS	S	1,2,7
Siouxland[1]	MR	MR	R	MR	1,2,3,4,6
Stallion[2]	S	MS	S	S	1,2,7
Sturdy[1]	MS	MS	MS	S	1,2,3,4,6
Tam 101[1]	S	MS	S	S	1,2,7
Tam 105[1]	S	MS	S	S	1,2,7
Tam 107[1]	S	MS	R	MS	1,2,7
Tam 108[1]	S	MR	R	S	1,2,7
Taylor-Evans 5221[2]	MR	MR	MR	MS	1,2,3,4
Thunderbird[2]	R	MR	S	MS	1,2,3,6
Victory[2]	R	MS	MR	MS	1,2,7
Vona[1]	S	S	S	S	1,2,7
Wrangler[2]	S	MR	S	MS	1,2,7

a/ A 1/ next to a variety name denotes a publicly-developed variety and a 2/ denotes a privately-owned variety. Our data on privately-owned varieties are somewhat limited. The owner should be consulted for recommendations on privately-owned varieties.

b/ Refer to map in Figure 1 for numbered production areas. Varieties are catagorized to a production area on the basis of testing trials, over-years performance and susceptibility to leaf rust.

R = resistant
MR = moderately resistant
MS = moderately susceptible
S = susceptible

SOFT RED WINTER WHEAT

Variety a/	Leaf Rust	Stem Rust	Powdery Mildew	Septoria	Best b/ Production Area
Bradford[1]	MR	MS	R	MR	3,4,6
Caldwell[1]	MR	R	R	MR	3,6
Coker 68-15[2]	MS	MR	MS	MS	3,4,6
Coker 762[2]	MR	S	R	MR	3,6
Coker 797[2]	MR	S	R	MR	3,6
Coker 916[2]	MS	S	R	MR	3,6
Coker 983[2]	MS	S	R	MR	3,6
Florida 301[1]	MS	MR	MR	MS	6
Florida 302[1]	R	R	R	MS	3,4,5,6
HW 3015[2]	MS	-	4	MS	3,4,6
HW 3021[2]	S	-	R	MS	3,6
HW 3022[2]	MS	-	MS	MS	3,6
Hunter[2]	MR	MS	R	MR	3,4,6
Magnum[2]	MS	MS	MR	MR	3,6
McNair 1003[2]	S	S	MS	MS	6
Southern Belle[2]	MS	MS	MS	MS	3,4,6
Terral 812[2]	MR	S	MR	MR	3,6
Terral 817[2]	MR	R	R	MR	3,4,5,6

a/ A 1/ next to a variety name denotes a publicly-developed variety and a 2/ denotes a privately-owned variety. Our data on privately-owned varieties are somewhat limited. The owner should be consulted for recommendations on privately-owned varieties.

b/ Refer to map in Figure 1 for numbered production areas. Varieties are catagorized to a production area on the basis of testing trials, over-years performance and susceptibility to leaf rust.

R = resistant

MR = moderately resistant
MS = moderately susceptible
S = susceptible

HARD RED SPRING WHEAT

Variety a/	Leaf Rust	Stem Rust	Powdery Mildew	Septoria	Best b/ Production Area
DK 22S2	MS	-	-	MS	4
DK 33S2	S	-	-	MS	4
DK 35X2	MR	-	-	S	4,5
DK 49S2	MS	-	-	MS	4,5
Milam1	MR	MR	MS	MS	4,5
Nadadores 631	MR	MR	MS	MR	4,5

a/ A 1/ next to a variety name denotes a publicly-developed variety and a 2/ denotes a privately-owned variety. Our data on privately-owned varieties are somewhat limited. The owner should be consulted for recommendations on privately-owned varieties.

b/ Refer to map in Figure 1 for numbered production areas. Varieties are catagorized to a production area on the basis of testing trials, over-years performance and susceptibility to leaf rust.

R = resistant
MR = moderately resistant
MS = moderately susceptible
S = susceptible

Consult the Chemical Control Supplement (B-1140A) for specific chemical control suggestions.

CASTORS

Ricinus communis

Seed Rot and Seedling Blights (fungi and bacteria - several genera): A great deal of damage occurs to cultivated castor in the seedling stage. Seed-borne diseases were once considered uncommon, but at least ten parasitic fungi have been isolated from castor seed. Many of these penetrate the testa making disinfection difficult. Many of these fungi attack irrigated plantings of castor at any stage of growth, though most damage is on young plants.

After germination, seedlings are susceptible to a number of root and stem rot organisms, which become more dangerous in wet soils. The most common of these are species of Fusarium, Rhizoctonia and Sclerotium, all major pathogens of seedlings and capable of decimating young plants. The incidence of seedling wilt can be related to temperature, maturity of the seed planted and variety. Plants infected as seedlings may be predisposed to later fungal infection. Stunting accompanied by a black rot in the tap root, and elongated, brown lesions on the hypocotyl was caused by Thielaviopsis basicola. The use of a fungicide seed treatment is recommended for areas where seedbed temperatures may be lowered after planting, where the incidence of soil-borne pathogens is known to be high, and for irrigated plantings. Where the specific organism has not been identified in an area, suitable seed treatment may be obtained by following cotton recommendations, providing the chemicals have been cleared for the castor crop.

Charcoal Rot (fungus - Macrophomina phaseolina): This is a widespread and frequently serious disease of many crops. When intercropping and rotation are practiced, the disease becomes more damaging when all the crops are susceptible. Charcoal rot develops rapidly on crops under moisture stress after flowering and seedset. Temperatures between 77 and 95^{O}F favor rapid growth of the fungus. The disease causes blackening of the stem near the soil line, followed by premature death.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Castor is very susceptible and should not be planted in soils where the fungus is established. Cultural practices as recommended for root rot control of cotton may be effective.

Leaf Spot (fungus - Cercospora ricinella): Light brown, generally circular interveinal spots with margins of concentric rings, are produced. With age, the center of the spot changes to light gray.

Leaf Spot (fungus - Alternaria recini): Light brown, generally circular spots appear on leaves that are larger than Cercospora, which tend to become angular with age. A gray-green spore mass may sometimes be seen.

Bacterial Leaf Spot (bacterium - Xanthomonas ricinicola): Numerous, irregular, small, brown watersoaked spots occur on leaves, followed by premature defoliation. Spots gradually turn black with dried sections of leaf tissue disintegrating and falling from leaves. Racemes are attacked under humid conditions. Serious losses may occur under humid conditions.

Bacterial Leaf Rust (bacteria - Pseudomonas sp.): Leaves dry up, turn black and fall. Branches also turn black, and stems may be affected, in which case the plants usually die.

Gray Mold (fungus - Botrytis ricini): The entire group of flowers is attacked and converted to a prominent wooly mass of fungal growth. Also affects leaves and stems by infection from racemes. First symptoms are small, blackish spots from which drops of yellow may exude. Fungal threads which grow from these spots spread the infection and produce the characteristic wooly appearance of the inflorescence.

Capsule Molds (fungi - Alternaria sp., Penicillium sp., and Fusarium sp.): Capsules are attacked at an early stage of development. Capsules have distinctive bluish color in early stages. Color may become darker or black in later stages of development.

[Blank Page in Original Bulletin]

COTTON DISEASES

An Aid to Identification and Control

1. POST-EMERGENCE DYING OF COTTON SEEDLINGS

2. ASCOCHYTA SEEDLING BLIGHT

3. ASCOCHYTA WET WEATHER BLIGHT

4. BACTERIAL ANGULAR LEAF SPOT

5. FUSARIUM WILT OF COTTON WITH CROSS SECTION OF DISEASED STEM

6. VERTICILLIUM WILT DAMAGE TO COTTON STEM

7. STING NEMATODE AND WILT DAMAGE TO COTTON

8. STING NEMATODE DAMAGE TO ROOTS OF COTTON

9. TYPICAL BOLL ROT DAMAGE TO COTTON

PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

[Blank Page in Original Bulletin]

COTTON

Gossypium hirsutum

Seedling Disease Complex (fungi - *Rhizoctonia solani*, *Fusarium* sp., *Pythium* sp., *Thielaviopsis basicola*.): Seedling diseases often occur in combinations, thus the term "seedling disease complex." Seedling infection occurs either pre-emergent or after seedlings emerge from the soil. Damaged seedlings may show stunting, slow growth and chlorosis. Plants pulled from the soil often have rotted roots and sunken dark lesions on the hypocotyl (that area between roots and stems). The greatest loss from seedling disease may not necessarily be from a thinner stand but from poor vigor of surviving seedlings. For instance, when *Thielaviopsis* attacks seedling cotton, plants do not usually die, but the tap root is damaged to the point that essentially a new root system has to be grown. Seedling diseases are most severe when poor quality seed are planted. The problem is compounded if poor seed are planted in cold, wet soil. Under these conditions, cotton grows poorly but the disease-causing fungi grow rapidly. Chemical injury such as herbicide damage may also predispose cottonseed to disease organisms. Control is best achieved by utilizing both cultural and chemical practices. They are as follows:

1. use high quality seed, preferably acid delinted and graded. Germinated tests should be made at 65°F,
2. plant on raised, well-prepared seed beds and at a minimum depth,
3. plant when soil temperature at an 8 inch depth reaches 65°F for 4 continuous days,
4. practice crop rotation,
5. do not plant more than 25 pounds of delinted seed per acre,
6. treat seed with at least one recommended seed-protectant fungicide. Combination fungicide treatment should be considered on poor quality seed, and
7. in-furrow fungicides have proven effective in early plantings, where stand losses have occurred.

Bacterial Blight (bacterium - *Xanthomonas campestris* pv. *malvacearum*): Also known as angular leaf spot, vein blight, black arm and boll rot, depending on the portion of the plant infected. This organism affects all above ground parts of the cotton plant during any stage of its growth. Angular spots first appear on the leaves as water-soaked areas; the spots later turn dark brown to black and are covered with a glazed film. Often the surrounding tissue becomes yellow, giving a halo effect. Leaf spots are limited in size by leaf veins, which result in an angular shape. Infected leaves shed from seedlings and older plants. Occasionally, a black, water-soaked area occurs along a large vein in a leaf. Spots on bolls appear as round, water-soaked areas, but later turn dark brown or black. Spotted bolls may fail to open and lint may be discolored with a yellow stain. Before boll rot is evident, dark, irregularly shaped spots can be found on bracts surrounding the lower portion of the boll. Black spots or cankers may occur on the stems or branches (black arm) causing girdling and death of some branches. Overall, leaf spots and defoliation are the most noticeable symptoms and they are most likely to occur during or following rainy periods. Control measures depend largely on eliminating sources of infection and growing resistant or tolerant varieties. Since the bacterium overwinters in crop residue, plowing under the stubble immediately after harvest and practicing crop rotation will help reduce inoculum in the field. Acid delinting of cottonseed will prevent external carry-over. Resistant or tolerant varieties give excellent control of bacterial blight.

Cotton Root Rot (fungus - *Phymatotrichum omnivorum*): Root rot appears suddenly, starting in early summer. It causes rapid wilting, followed by death of the plants within a few days. Usually, the leaves of the plant are not shed, but remain attached. The disease kills plants in circular areas ranging from a few square yards to an acre or more in size. The root system of affected plants decay. A longitudinal cut reveals a darkened tap root with a reddish to wine-colored stain. If examined soon after death, the stems will be near normal color internally. Vascular streaking is not present as in the wilt disease. Fine, brownish strands of fungal threads (rhizomorphs) are usually found on the roots. Under moist conditions spore mats may appear on the soil surface near diseased plants. These are 2-12 inches in diameter, first snow-white and cottony, later tan and powdery. Controls include management and cultural practices as no chemical treatment has been found that economically controls cotton root rot. Deep plowing approximately 12 inches with mold board plow, planting early maturing varieties to escape disease, addition of organic or green manure and crop rotation have proven to be the most effective control methods. To achieve maximum control, an integrated program involving all practices is recommended.

Verticillium Wilt (fungus - *Verticillium albo-atrum*): Young plants infected with Verticillium wilt show yellow leaves and stunting, and often die. Following the seedling stage, older plants exhibit a chlorotic mottling on the leaf margins and between the major veins. Plants attacked during later stages of growth display a mottling on the lower leaves first, later progressing toward the top of the plant as the season progresses. Often a single branch shows symptoms in the early stages of disease. The chlorotic areas become larger and paler and the leaf finally dies. Severely affected plants shed all their leaves and most of their young bolls. These plants may survive throughout the growing season and send out young sprouts or shoots from the base of the plant. Verticillium wilt is difficult to distinguish from Fusarium wilt. Leaf symptoms are similar and the internal tissues of the stems are discolored in both diseases. The only reliable way to distinguish the wilts is through a laboratory isolation of the fungus. The fungus causing Verticillium wilt can survive in the soil as small, dark resting bodies called sclerotia. The sclerotia can withstand adverse environmental conditions. Susceptible plants growing in Verticillium infested soil may not be severely attacked if environmental conditions are not suitable for fungal growth. The disease is more prevalent during periods of cool, wet weather. The fungus is not transmitted in seed, but can be introduced in the field by infested gin trash and burrs. The disease is more common on heavier soils than on light sandy soils. Control measures include cultural practices as well as using resistant or tolerant varieties. Cultural practices include:

1. a balanced fertility program, particularly not applying excess nitrogen,
2. shallow and infrequent cultivation to avoid root pruning,
3. crop rotation, and
4. avoidance of excess irrigation.

Fusarium Wilt (fungus - Fusarium oxysporum f. sp. vasinfectum): Fusarium wilt is more prevalent in the lighter-textured soils of Texas. Unlike Verticillium wilt, seeds from diseased plants can become infected and serve to spread the fungus. The fungus may attack cotton seedlings, but the disease usually appears when the plants are more mature. Affected plants are first darker green and stunted, followed by yellowing of the leaves and loss of foliage. At times, the plants die so rapidly that leaves do not drop. Leaf discoloration will first appear around the leaf edges near a vein. Infected plants fruit earlier than normal with smaller bolls that open prematurely. A diagonal cut across the stem will reveal vascular discoloration just beneath the bark extending down the tap root. Wilting occurs rapidly following a rain preceded by a dry spell. Soils in which Fusarium wilt occurs also favor root knot nematodes and the two are often found together. Reniform nematodes (which occur mostly in the lower Rio Grande Valley) also predispose the plant to attack by the fungus. Control of nematodes is of major importance in reducing Fusarium wilt. Cultural practices effective for reducing Fusarium wilt losses include summer fallowing, rotation with non-susceptible crops, adequate potash and use of resistant varieties.

Root Knot (nematode - Meloidogyne incognita acrita): The symptoms caused by root knot vary from slight plant stunting to death in areas of severe infestation. Skippy stands, particularly in distinct areas of a field, are characteristic. In skip-row cotton, where current rows are laid out perpendicular to the previous year's row, stunted cotton outlining the old rows may be noticed. Root knots are small and should be checked on plants dug with a shovel and not those pulled by hand, since pulling plants often results in just the tap root being extracted. Control root knot nematodes by:

1) growing resistant varieties or tolerant varieties proven acceptable for the area,
2) rotate with non-related crops such as sorghum and small grains,
3) summer fallow,
4) use a recommended nematicide (see section on Root Knot Nematodes).

Nematodes Other Than Root Knot (nematodes - lesion: Pratylenchus sp., spiral: Helicotylenchus sp., lance: Hoplolaimus sp., sting: Benlonolaimus sp., stunt: Tylenchorhynchus sp., reniform: Rotylenchus reniformis): Of these nematodes, reniform is the most important in cotton production in Texas. It is most prevalent in the Rio Grande Valley area. For more information on these nematodes, see the section entitled, "Nematodes Other Than Root Knot".

Ascochyta or Wet Weather Blight - (fungus - Ascochyta gossypii): The disease is prevalent in most cotton producing areas of the state. Both seedlings and older plants are susceptible, but younger cotton is more seriously injured. An entire stand may be lost as a result of the fungus attacking the hypocotyl and killing the plant. Serious outbreaks of the disease may follow extended rainy periods with serious defoliation occurring. The damage is generally spotty and many plants recover when dry, warmer weather returns. The disease occurs on the leaves, stems and branches. First, small, round, reddish-brown spots with concentric rings appear on the leaves. Later, the center of the lesions become ashy in color and may fall out. The lesions often occur at the base of the petiole. Defoliation may result from large lesions that coalesce. On stalks and branches, the lesions are dark brown, elongated and slightly sunken. Under conditions favorable for the disease, the lesions may completely encircle the stem or branch and kill the plant above the lesions. The fungus may be seed-borne but it primarily survives in the soil on the infected plant residue. Use of acid delinted seed and suitable seed treatment fungicides will minimize carry-over. Plowing under plant residues and crop rotation also aid in reduction of the disease.

Rust (fungus - Puccinia cacabata): True cotton rust is quite distinct from the "rust" caused by potash deficiency. Cotton rust is confined to the Trans-Pecos area of West Texas, where it may reduce yields as much as 50 percent. Rust first appears as small, yellowish spots or pustules on leaves, bracts, green bolls, and stems. These enlarge, developing orange to reddish centers. Later, large orange pustules appear on the lower leaf surface and discharge orange spores (aeciospores). Several lesions on a leaf may cause it to shed. The rust lesions will also weaken stalks, stems and petioles, causing breakage on these parts. Broken stalks are more difficult to cultivate and harvest mechanically. The aeciospores released on the cotton do not reinfect cotton, but are wind blown to wild gramma grass, which serves as an alternate host for the fungus. A rainfall of 1/2 inch or more, followed by 12-18 hours of high humidity, is needed in June or early July for disease development. The only effective means of control is with an application of a foliar fungicide before the cotton is infected. No cleared chemical can control the fungus after infection has occurred.

Boll Rots (fungi and bacteria - caused by many parasitic and saprophytic organisms including: Colletotrichum sp. and Xanthomonas sp.): Symptoms may vary depending on the organisms involved. Generally, the first symptoms of boll rot are small, round, water-soaked spots on the bolls which may enlarge and become sunken and dark in color. External symptoms may be absent but complete destruction of seed and fiber will occur. Infected bolls may be reduced by avoiding practices that promote rank growth, keeping cotton free of weeds and grasses, and skip-row planting. Heavy insect injury increases boll rot incidence.

Minor Leaf Spots (fungi - Alternaria sp., Cercospora sp., Rhizoctonia sp., Stemphyllium sp.): Two or more leaf spots may occur at the same time. Symptoms are varied, but generally these organisms cause circular concentric lesions similar to a "target spot". These foliar diseases tend to be more prevalent at crop maturity and during periods of high humidity. Preventive control measures are most effective and include seed treatment, good management practices, and destruction of plant residue after harvest. Some varieties are more susceptible to late season leaf spot fungi.

Virus Diseases: Several virus diseases have been described on cotton but are only of minor importance in Texas.

COTTON

Response of Certain Cotton Varieties to Verticillium Wilt

RESISTANT

Acala 1517-70
Acala 3080
Dawson LV-14
GSA 74
GSA 78
Paymaster 266
Paymaster 303
Paymaster 909

MODERATELY RESISTANT

Cascot L-7
Dawson B-25
Delcot 277
Deltapine SR-5
Dunn 118
Dunn 120
Gregg 35 W
Paymaster 785
TAMCOT SP-21 S
TAMCOT SP-23
TAMCOT SP-37 H
TAMCOT 788

MODERATELY SUSCEPTIBLE

Aburn M
Blightmaster A-5
Cascot B-2
Coker 310
Coker 312
Coker 348
Coker 5110
Dawson E-10
Dunn 119
Deltapine SR-1
Deltapine SR-2
Deltapine SR-4
Earlycot 31
Earlycot 32
G & P 3774
G & P 3755
Gregg 45
GSA-71
Lamesa 5
Lambright GL-4
Lambright GL-N
Lockett BXL
Lockett 77
McNair 511
Northern Star 6
Northern Star R-4A
Paymaster 111-A
Paymaster 18
Paymaster 202
Paymaster 792
Quapaw
Rex 713
Rilcot Stripper N
Rilcot Stripper-Cala S
Stripper 31
Stripper 31 A
Stipper 32
TAMCOT CAMD-E
TAMCOT SP-37
Westburn 70
Westburn M

SUSCEPTIBLE

Anton 99
Blanco 3363
Lamesa 8
Lankart Sel. 611
Lankart LX 571
Lankart 3840
Lankburn
Lockett 4789 A
Northern Star 5
Rilcot 90
Rilcot 90-A
Western 44
Western Stormproof
Western Prolific
Stormproof

Varieties Resistant to the Fusarium Wilt-Nematode Complex[1/]

Auburn M
Cascot B-2
Cascot L-7
Delcot 277
Dunn 120
G & P 3755
G & P 3774
Lankburn
Lockett BXL
Lockett 77
McNair 511
Paymaster 303
Southwest - 2
TAMCOT SP-21
TAMCOT SP 21 S
TAMCOT SP-23
TAMCOT CAMD-E
TAMCOT SP 37 H
Westburn 70
Westburn M

[1/] Varieties other than those listed here may exhibit tolerance to this disease complex.

FLAX

Linum usitatissimum

Seedling Blight (fungi - Rhizoctonia solani, Pythium sp., others): Seedling blight is a complex disease, caused by several organisms. The fungus, Rhizoctonia solani, however, is the predominant organism. The fungus attacks young plants before and after emergence, and continues to attack surviving plants to a lesser extent during the growing season. Diseased plants have lesions on their roots immediately below the ground line. These lesions enlarge to kill seedlings and weaken older plants. Flax plants with roots injured by Rhizoctonia solani appear to be considerably more susceptible to damage by cold weather and root rotting fungi. The disease can be controlled by using a combination of practices such as using high quality seed with germination of at least 90 percent, avoid planting when temperature are too high; rotate crops to include a grass crop prior to flax; plant in a well-prepared, firm bed. Use recommended seed and soil treatment fungicides.

Pasmo (fungus - Septoria linicola): This is probably the most important disease of flax in Texas. Lesions develop first on the cotyledons and later on the lower leaves of the seedling. Lesions are usually circular and vary in color from greenish yellow to dark brown, depending upon age. Later, stem lesions develop, first as small elongated lesions which then enlarge and coalesce, extending around the stem as well as longitudinally. The infected areas alternate with green tissue until infection becomes severe; then the stems brown as the plants are defoliated. There is no evidence that the fungus oversummers in Texas, so it is likely that the disease is primarily seed-borne. Rotation and removal of straw or covering the straw with plowing helps reduce the inoculum. Use seed treatment and resistant varieties.

Rust (fungus - Melampsora lini): This disease can be readily recognized by the reddish, raised spots on leaves and stems. Early in the season, the rounded bright orange pustules can be seen on leaves. Later, the pustules turn black, causing defoliation of plants. The disease is favored by cool, moist weather. It is spread by spores produced in the pustules. The rust organism overwinters in flax straw, from which spores are produced that cause primary infection. Susceptible varieties such as De Oro should not be grown in Texas. New races of the fungus develop; therefore, epidemics are likely to occur until new resistant varieties are developed.

Aster Yellows (mycoplasma): The causal agent is transmitted from diseased to healthy plants by the six-spotted leafhopper. Infected plants are bright yellow with considerable distortion of foliage and floral parts. Flower parts turn green, forming a rosette-like growth instead of a boll. Seeds are shriveled or do not form. There is no effective control for this disease. Dense plantings tend to reduce the incidence of disease, since the insect vector prefers plants that are not crowded.

Curly Top (virus): The vector of this disease is the beet leafhopper, an insect which prefers arid conditions; therefore, the disease is more prevalent during dry years. Infected plants show a characteristic erectness of leaves about the stem. Plants may be yellow or reddish in color and the lower leaves drop prematurely. Later, plants branch abnormally, sometimes with tops twisted. Plants affected by curly top are more susceptible to Rhizoctonia root rot. There is no effective control for this disease.

Wilt (fungus - Fusarium oxysporum f. sp. lini): The fungus can attack flax plants at any stage of growth. In the seedling stage, roots are ashen-gray in color and the small plants wilt and die. In older plants, leaves turn yellow at the tip first, turning completely yellow later on. The disease is seed and soil-borne, and affects plants mostly when temperatures are high. Since flax in Texas is grown in the winter, the disease has not caused serious problems. Most common varieties are resistant.

Boll Blight (fungi - various organisms): Several fungi are involved in the complex disease. The fungi invade the capsule, turning the pod black and causing discoloration and rotting of grain. The disease is enhanced by insect damage and humid, wet conditions. Some varieties are more resistant to the disease because of the structural shape of the pod, which deters the entrance of organisms.

Other disorders: Mineral deficiencies, particularly iron and zinc, occur commonly in Texas. Zinc deficient plants show death of the terminal bud, profuse tillering and necrosis of the leaves. Plants are small and unthrifty with reduced yields. Another condition, late season decline, results in the wilting of plants brought about by drought stress during the flowering stage.

FLAX

	Disease		
Variety	Rust	Pasmo	Boll Blight
Dillman	R	MS	S
Mac	R	MS	S
Tam - 201	R	MS	MR
Deoro	HS	MS	R
Nored	R	R	MS
B - 5128	MR	MR	MS

HR = Highly Resistant
R = Resistant
MR = Moderately Resistant
MS = Moderately Susceptible
S = Susceptible
HS = Highly Susceptible

GUAR

Cyamopsidis tetragonoloba

Leaf Spots (fungus - *Alternaria* sp.): Many small-to-large weather-soaked spots appear on the leaves. Defoliation may follow under sprinkler irrigation or in rainy seasons.

Southern Blight (fungus - *Sclerotium rolfsii*): Plants affected by the southern blight fungus begin to wilt, leaves turn crisp brown and the entire plant dies. Cutting into the stem shows a brown discoloration in the vascular tissue. A white mold growth will be apparent on the stem about the soil line. As the white mold ages, white-to-brown small, bead-like structures (sclerotia) form. These are overwintering structures of the fungus. Rotation, deep burial of residue, and planting on a raised bed will aid in reducing southern blight.

Top Necrosis (virus): Young leaves are curled, shed from the plant, and the terminal end of the stalk dies and turns black.

Bacterial Blight (bacterium - *Xanthomonas cymopsidis*): This is a seed-borne disease that causes loss of plants from seedling stage to maturity. Large angular lesions develop on the leaves which cause defoliation and black streaks in the stem.

Other diseases: Fusarium wilt, the cotton root rot fungus, curly top virus, and root knot nematodes attack guar plants. (See the appropriate sections for more details on these disease problems.)

PEANUT

Arachis hypogaea

Seed Rot and Seedling Disease (fungi - *Rhizoctonia solani*, *Pythium* sp., *Fusarium* sp., *Aspergillus niger*); Several soil-borne fungi attack seed and seedlings and subsequently reduce stands. Seed may decay prior to emergence or seedlings may become infected and die. Low quality seed are especially susceptible. Rhizoctonia produces brown-to-black lesions that may completely girdle the stem. Pythium invades the entire stem and turns it light brown. Seedling disease is more severe when temperature and moisture conditions are unfavorable for germination and seedling growth. Control this condition by use of recommended seed treatment, good seed bed preparation, keeping crop residue out of the seed zone, avoiding cold wet soils and using high quality seed.

Leaf Spots (fungi - *Cercosporidium personatum* and *Cercospora arachidicola*): Circular spots appear on leaves. Early leaf spot (*C. archidicola*) produces a brown-to-black spot that usually has a yellow halo around each spot. The spot appears brown on the lower leaf surface. Late leaf spot (*C. personatum*) also produces a circular spot, but is darker (dark brown-to-black) and usually has no halo. Late leaf spot viewed from the lower leaf surface has visible fungus growth that is black to gray in color. Both can occur at any time during the season when relative humidities are high, but early leaf spot (*C. archidicola*) is usually more prevalent early, with late leaf spot building up to damaging proportions in late season. Both organisms overwinter in the soil on infected plant residue.

Secondary spread also occurs because air-borne spores are produced on aboveground portions of the plant. Symptoms become visible approximately 10 to 12 days after infection. A toxin is produced which causes defoliation. Fallen leaves serve as a food source for the southern blight fungus. Use recommended fungicides, rotate with other crops and bury crop residue deeply.

Rust (fungus - *Puccinia arachidis*): Peanut rust can be identified by the presence of pustules (mostly on lower leaf surface) that rupture and release brownish red spores. Rubbing the lower leaf surface with white cloth will reveal presence of spores. Infection can occur on the leaflets, petioles and stems. There is no evidence that the fungus overwinters in the United States. Spores are apparently windblown from the Caribbean area. Occurrence is sporadic, but becomes serious in areas of South Texas during certain years. Growers should observe fields closely for the first evidence of rust development. Fungicides effective against the rust fungus should be applied at regular intervals when infection threatens. Digging and combining allow large number of rust spores to be carried in the wind. Growers in South Texas should consider fungicide applications on late planted fields as harvest of infected early peanuts begins.

Web Blotch (fungus - *Phoma arachidicola*): The disease first appears as a bronze web-like pattern on the upper leaf surface. The web-like outline caused by fungal strands becomes darker in color. Large brown blotches often accompany the webbing, thus the name "web blotch". The fungus overwinters in crop residue and infection takes place when temperature and moisture conditions are favorable. Chemical control helps reduce damage.

Florunner is less affected than Spanish-type varieties.

Other Leaf Spots (fungi - Leptosphaerulina crassiasca, Alternaria sp. and others): Pepper spot is caused by L. crassiasca and produces numerous small, black spots on the leaf surface. These spots may run together and give the leaf a netted appearance. This disease usually does not cause severe damage. It can be controlled with certain fungicides which also control leaf spot. A number of other leaf spot diseases may occur. These minor diseases can become important under certain conditions.

Southern Blight (fungus - Sclerotium rolfsii): A white fungus growth develops on stems, pegs and pods of infected plants. Fungal strands may be present on most any type of crop residue including leaves that have dropped following leaf spot infection. Sclerotia (overwintering fungal structures) are also present with the fungal strands. Sclerotia are first small and white, but increase in size and become darker in color with with age. These become dark brown-to-black. Development of fungal strands on plant tissue causes it to die. Affected pegs are weakened, thus leaving pods in the soil at harvest. Deep burial of crop residue and planting on raised beds reduce loss. Certain soil fungicides are recommended when southern blight is identified as the limiting production factor. Rotation with unrelated crops is helpful, but it should be kept in mind that the fungus is capable of colonizing most crop residues.

Pythium Pod and Root Rot (fungus - Pythium myriotylum): This fungus causes severe damage when certain soils are too wet for a prolonged period of time. This "water-mold" organism develops rapidly in pod tissues. Affected pods turn black and the kernels decay completely. The decay can be characterized as a wet rot as compared to a drier decay with southern blight. Part or all pods on a given plant may be affected. Certain soils seem to favor Pythium development on peanuts. Excessive moisture is an obvious contributing factor, but other factors are also involved. Avoid excessive use of irrigation, rotate with other crops and use fields that are less prone to the disease when possible. Calcium supplements at pegging may be needed, especially where irrigation water is high in soluble salts. A systemic soil fungicide may help protect pods when Phythium is the primary agent causing pod rot. Avoid high potassium (K) levels in soil.

Rhizoctonia Pod and Peg Rot (fungus - Rhizoctonia solani): Lesions or spots produced by this fungus are brown-to-black and slightly sunken. This fungus is capable of attacking any plant part including seed coats. This disease is likely to be a greater problem where peanuts have been grown continuously and the population of this fungus has built up in the soil. Certain soil fungicides have given some control. Cultural practices given for southern blight control are also helpful. Recommended fungicides should be considered.

Diplodia Collar Rot (fungus - Diplodia gossypina): This disease causes an occasional problem in dryland production areas. Individual limbs die with the entire plant being killed after the crown and taproot become infected. Rotation with unrelated crops, avoiding drought stress and deep burial of crop residue constitute the best means of control.

Charcoal Rot (fungus - Macrophomina phaseolina): Charcoal rot symptoms are similar to Diplodia collar rot. There is a noticeable shedding of infected stem tissue with black specks (sclerotia) mingled with the diseased tissues. The fungus causing this disease typically invades tissue when there is drought stress. This disease seldom causes substantial damage.

Spotted Wilt (virus - Tomato Spotted Wilt Virus): This disease caused economic losses in South Texas. TSWV is moved from plant to plant by thrips, and weeds are the overwintering site for the virus. TSWV is not seed borne. Early infected plants are stunted and may have ringspots and light green and yellow spots on leaves. Terminals sometimes die and secondary buds may proliferate. Plants may die at anytime during the season, and mature plants with minor ringspot symptoms may suddenly turn yellow and die. Red seed skins occur in high levels when the epidemic peaks late in the season.

Growers in areas where risk is greatest should use as many prevention methods as possible.

- Reduce sources of TSWV: control broadleaf weeds and brush in and near fields; and avoid planting next to infected potatoes, peas, peanuts and ornamentals.

- Avoid attracting thrips: get rapid dark green ground cover with adequate seeding rates, quality seed, and narrow row spacings or multiple rows per bed; choose a runner variety; and provide adequate major and minor nutrients.

- Reduce thrips numbers: use a systemic granular insecticide at planting (or split application) and follow with foliar insecticide sprays.

- Intercept migrating thrips: plant a tall grass crop around peanut fields or in frequent strips through fields and keep these strips weed-free.

Peanut Mottle (virus - Peanut Mottle Virus): Low incidences of peanut mottle occur wherever peanuts are grown in Texas. It causes no detectable economic damage. Symptoms are a slight cupping and an irregular growth of leaves. Leaves display a mottled appearance when held up to the light. There is a low level of seed transmission of PMV and aphids move it from plant to plant.

Peanut Stripe (virus - Peanut Stripe Virus): This virus occurs in Texas in isolated areas but has not been found in commercial fields at this time. It is aphid and seed borne. Greenhouse studies indicate yield reductions may reach the 30% level, but field tests have not shown this severe effect. Symptoms such as mottling and an oak leaf pattern are characteristic of infection. If you, as a producer, see symptoms that you suspect might be peanut stripe, disease samples should be sent to the Texas Plant Disease Diagnostic Laboratory at College Station for positive identification.

Nematodes: A number of nematodes affect peanuts. They are listed below along with the damage they cause.

Root-Knot (Meloidogyne arenaria and Meloidogyne hapla)	These are the most destructive nematodes on peanuts. Knots or galls are are formed where these nematodes feed on root, peg, or pod tissue. These galls should not be confused with nodules produced by nitrogen-fixing bacteria. High populations can reduce production below the profitable level. Rotate with non-susceptible crops and use chemical control.
Root Lesion (Pratylenchus brachyurus)	This nematode is widely distributed in all peanut growing areas. Damage can be substantial when populations build up. Pods and pegs are affected. Light brown, circular spots with a black pinpoint center are diagnostic features. Feeding areas become infected with fungi which obscure symptoms. Chemical control is suggested when this nematode represents a limited production factor.
Sting (Benlonolaimus longicaudatus)	Sting nematodes cause little damage in Texas. Affected plants are stunted, chlorotic and have sparse, stubby roots. Control with nematicides is effective.
Ring (Criconemoides sp.)	Ring nematodes are widely distributed in all peanut growing areas. They have been reported to cause stunting, but this is not a reliable symptom for field diagnosis. High populations of this nematode are required to produce substantial yield loss.

Nematode Problems Should Be Correctly Identified: Soil samples may be sent to Plant Nematode Detection Laboratory, Texas Agricultural Extension Service, Room 101, L. F. Peterson Building, College Station, TX 77843.

Aflatoxin (fungi - A. flavus and Aspergillus parasiticus): Certain fungi have been shown to produce toxic by-products. The most common identified toxin in peanuts has been aflatoxin produced by these fungi. Infection can take place in the field, the windrow or in trucks or trailers at harvest, before proper drying occurs. No practice has been found that will completely eliminate the problem, but several suggestions are made for reduction.

1. Avoid severe drought stress when possible.
2. Avoid certain fields prone to have a higher incidence.
3. Dig when mature.
4. Try to avoid harvest periods when rains are expected before harvest can be completed.
5. Avoid damaging peanuts at harvest.

6. Dry peanuts to a safe storage level as soon as possible after harvest.

Sclerotinia Blight (fungus - *Sclerotinia minor*): This disease was first observed in Texas in 1981 even though it had been common in Oklahoma, Virginia and North Carolina for several years. Early symptoms include white tufts of cottony-like growth on stems near the groundline. Later stems shred and reveal black sclerotia inside the stems. Avoid planting peanuts in fields with a history of this problem. Check current chemical clearances for potential application.

Botrytis Blight (fungus - *Botrytis* sp.): This disease is only a problem in far western Texas. Since symptoms so closely resemble Sclerotinia blight, a lab diagnosis is necessary to separate the two.

PEANUT

	Early Leafspot	Late Leafspot	Rust	Spotted Wilt	Pythium Pod Rot	Web Blotch	Southern Blight
Starr*	HS	HS	S	S	HS	HS	S
Toalson*	HS	HS	S	S	MR	HS	S
Tamnut-74*	HS	HS	S	S	HS	HS	S
Pronto*	HS	HS	S	S	HS	HS	S
Langley**	-	-	S	S	HS	-	-
Florunner**	MS	HS	S	S	HS	MR	HS
Southern Runner**	MR	MR	MR	MR	-	-	-

HS = Highly Susceptible
S = Susceptible
MR = Moderately Resistant

* Spanish (market type)
** Runner

[Blank Page in Original Bulletin]

SOYBEAN DISEASES

An Aid to Identification and Control

1. BACTERIAL LEAF DISEASE

2. DOWNY MILDEW

3. CERCOSPORA LEAF SPOT

4. STEM AND POD BLIGHT

5. SOUTHERN STEM BLIGHT

6. ANTHRACNOSE ON STEM

7. STING NEMATODE DAMAGE TO ROOTS

8. LANCE NEMATODE DAMAGE

9. PURPLE SEED STAIN

PREPARED BY THE CLEMSON UNIVERSITY COOPERATIVE EXTENSION SERVICE'S ENTOMOLOGY - PLANT PATHOLOGY AND AGRICULTURAL COMMUNICATIONS SECTIONS, FEDERAL EXTENSION SERVICE COOPERATING

[Blank Page in Original Bulletin]

SOYBEAN DISEASES I

1. Pythium seedling rot

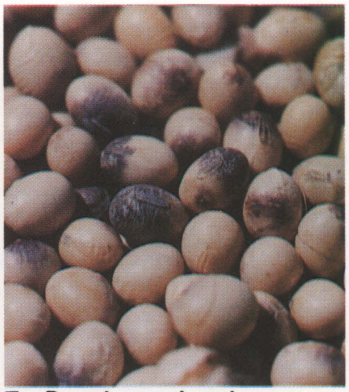
2. Rhizoctonia root rot

3. Soybean cyst nematode. L, field damage; R, cysts on roots

4. Phytophthora root and stem rot

5. Brown stem rot

6. Charcoal rot



7. Purple seed stain

8. Powdery mildew

9. Septoria brown spot

10. Anthracnose

11. Stem canker

12. Pod and stem blight. L, pycnidia on stems and pod; R, infected seed

13. Downy mildew. L, upper and C, lower leaf surface; R, infected seed

SOYBEAN DISEASES I

1. **Pythium Seedling Rot** is caused by several species of soil-borne fungi in the genus *Pythium*. Diseased plants may occur singly, in small circular patches--especially in low areas in the field--or uniformly over an entire field following a rainy period. Seedlings may rot before emergence. Plants that do emerge may wilt later, then turn brown and die. Pythium causes a soft watery rot. Damge is most severe in cold, wet soil. The fungi survive in soil and crop debris as oospores and mycelium.

2. **Rhizoctonia Root Rot** is caused by the common soil-borne fungus *Rhizoctonia solani*. Seedlings or somewhat older plants wilt and may die from a firm, dry, brown to reddish-brown decay of the roots and stem below or near the soil line. The fungus also causes pre- and post-emergence damping-off. Damage is most severe in heavy, poorly-drained soils where groups of affected plants commonly wilt and die in areas 4 to 10 feet in diameter. The *Rhizoctonia* fungus survives indefinitely in soil as mycelium and sclerotia.

3. **Soybean Cyst Nematode,** caused by *Heterodera glycines*, is a serious pest and major threat to soybean production. Severely infected plants are stunted and yellowed (chlorotic) and may die in areas of fields. Lightly infected plants appear normal, especially when growing conditions for soybeans are favorable. Pinhead-sized, shiny, white to yellow females or brown cysts (dead female bodies) are attached to the roots. The cysts are much smaller than the larger and loosely attached bacterial nodules. The dark brown cysts persist for years in the soil. The cysts are easily spread in even small bits of soil.

4. **Phytophthora Root and Stem Rot** is caused by the soil-borne fungus *Phytophthora megasperma* var. *sojae*. Affected plants turn yellow, wilt, wither and die at any age, leaving short to long gaps in rows. Seedlings may be attacked and die before or after emergence. A dark brown root rot can be found on older plants, with the dull brown discoloration extending up the stem into the lower branches. Phytophthora rot is most severe in low, poorly-drained, heavy clay soils following cool and rainy weather. The *Phytophthora* fungus survives in soil and buried crop debris as oospores or mycelum.

5. **Brown Stem Rot** is caused by the soil-borne fungus *Phialophora gregata* (synonym *Cephalosporium gregatum*). The disease usually becomes apparent about midseason by a dark reddish-brown discoloration inside the lower stem when the stem is split. The browning can be confused with that caused by other pathogens and should **not** be considered as diagnostic. Certain fungal strains cause the leaves to scorch between the veins, wither, and drop early. External symptoms are not observed on infected plants until pod set. The causal fungus survives in soybean debris as mycelium.

6. **Charcoal Rot** is caused by the fungus *Macrophomina phaseolina*. The disease appears in dry, hot weather or when plant growth is limited by some factor. Affected plants lack vigor and die early. Numerous black specks (sclerotia) appear when the "bark" is peeled from the stem base and roots giving diseased tissues a grayish-black color. Black streaks appear inside the roots and lower stem when the plant is split open. Sclerotia are frequently formed in the pithy area of the stem. The disease is most common in the southern half of the USA. The fungus survives as sclerotia in soil and the debris of many crops, including soybeans.

7. **Purple Seed Stain** is caused by the fungus *Cercospora kikuchii*. A pink or pale to dark purple coloration of the seedcoat is the most characteristic symptom. Diseased seed are often dull, cracked and rough. Small, inconspicuous, angular, reddish-brown spots form on the leaves, stems and pods. Infected seeds may reduce the stand or often produce diseased seedlings. The fungus survives in seed and crop debris as mycelium with infection favored by prolonged moist weather from pod set to harvest.

8. **Powdery Mildew** is caused by the fungus *Microsphaera diffusa*. Superficial, white to pale gray powdery patches form on the leaves. The soybean tissue underneath is reddened. Where the disease is severe, affected leaves wither and drop early. The mildew fungus is believed to survive in living leaves in the southern states. The disease is favored by warm dry days and cool nites.

9. **Septoria Brown Spot** or brown spot is caused by the fungus *Septoria glycines*. Small, angular to irregular, chocolate- to reddish-brown spots form on both surfaces of the leaves. The lower and older leaves gradually turn yellow and drop early. Black specks (pycnidia) form in the older lesions. In wet weather, infections progress from the lower to the upper leaves. Late in the growing season, infected leaves turn rusty-brown and drop early. The fungus survives as mycelium in crop debris and seed.

10. **Anthracnose** may be caused by two fungi, *Colletotrichum dematium* var. *truncata* and *Glomerella glycines*. The former fungus is much more common in the Midwest, infecting plants of all ages. *G. glycines* only infects older plants. Both fungi produce similar symptoms. Indefinite, enlarging, reddish- or dark-brown areas develop on the stems and pods. Later, these areas are covered with black fungal fruiting bodies (acervuli) that resemble tiny pin cushions containing black spines (setae) that are easily seen with a hand lens. Infected seed may be shriveled and moldy, or near normal in appearance. The anthracnose fungi survive as mycelium in crop debris and in seed.

11. **Stem Canker** is caused by the fungus *Diaporthe phaseolorum* var. *caulivora*. Dark, reddish-brown then tan, girdling cankers form in the stem at the base of a branch or leaf petiole, usually at the 4th or 5th nodes, starting about the beginning of pod set. Affected plants, which are usually scattered in a field, commonly wilt, wither and die early with the dead, dried leaves remaining attached. Small, reddish-brown lesions on the cotyledons may cause infected seedlings to wither and die. The fungus survives in crop debris and seed as mycelium.

12. **Pod and Stem Blight** is caused by the fungus *Diaporthe phaseolorum* var. *sojae*. Plants when near maturity develop large numbers of black specks, fungal fruiting bodies (pycnidia), in straight rows along the stems and scattered on dry, poorly developed pods. Heavily infected seed are dull, badly cracked, shriveled, and often covered partially or completely with a white mold growth. Sowing diseased seed commonly results in seed decay, seedling blights, and often a poor stand in the field. The fungus survives as mycelium in crop residues and seed.

13. **Downy Mildew** is caused by the fungus *Peronospora manshurica*. Indefinite, yellowish-green areas appear on the upper leaf surface. The lesions enlarge and turn a grayish-brown to dark brown surrounded by a yellow-green margin. The disease gets its name from the grayish to pale purple tufts of mold that form directly on the undersides of the leaf lesions in damp weather. If severe, some leaves wither and drop early. A whitish crust, composed of mycelium and oospores of the fungus, may form on infected seed. The fungus survives as thick-walled oospores in infected leaves and on the seed.

For chemical and cultural control suggestions, a listing of resistant varieties and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.

Photo credits: R. F. Nyvall (1, 7), G. W. Simone (2, 13L), University of Illinois (3, 4, 5R, 6, 8, 9, 11, 12L, 13L and R), J. M. Dunleavy (5L), T. M. Sjulin (10), R. W. Samson (12R), and K. L. Athow (13C).

SOYBEAN

Glycine max

Seed Decay and Seedling Diseases (fungi - *Pythium* sp., *Phytophthora* sp., *Rhizoctonia* sp., *Diaporthe* sp. are the most common): Poor seed quality, whether due to physical, physiological or pathological causes, predisposes seedlings to disease organisms. Poor seed quality is a major problem confronting soybean producers. Mechanical injury can rupture the seed coat allowing penetration of various pathogenic organisms or actually injury the embryo itself. Seed quality can be lowered by improper storage conditions, which include too high or too low moisture or temperatures. Both seed and soil-borne organisms can cause seed decay and seedling diseases. Seedlings infected with Pythium or Phytophthora usually develop a watery rot on roots and lower stems. Rhizoctonia causes a dry rot with reddish-brown lesions, typical of "sore-shin". Cool, wet soil conditions enhance seedling diseases. In poorly drained soils, plant soybeans on a slightly raised bed when temperatures have warmed up enough for rapid germination. Plant only high quality soybean seed if available. If planting seed germination is below 80 percent, use a seed treatment fungicide to increase germination.

Charcoal Rot (fungus - *Macrophomina phaseolina*): Charcoal rot is usually found in mid-summer, mostly on sandy soils. This fungus is a weak pathogen and generally attacks young plants when their growth is retarded by drought. The fungus attacks the roots and lower stem. When the bark is peeled from the roots and stem base, small black, pimple-like fruiting bodies may be seen. The root and base of the stem exhibit streaks in the woody portion when split open. (See chapter on Charcoal Rot for additional information.)

Southern Blight (fungus - *Sclerotium rolfsii*): Occurrence of southern blight in a field is erratic and generally only individual plants are affected. However, in some instances as many as 50 percent of the plants may be killed. Like charcoal rot, southern blight produces a rot of the roots and stem. Plants may be affected at any stage of growth. The first symptom is sudden wilting and subsequent death. The fungus produces a cottony growth on the stem base and sometimes on the ground around the stem. Sclerotia (resting bodies) about the size of mustard seed are formed. The sclerotia are the resting stage of the fungus and will persist in the soil for years. The fungus occurs widely in many soils. It is capable of persisting on almost any type of organic matter. Plowing of crop residues will aid in reducing losses from this disease.

Phytophthora Root and Stem Rot (fungus - *Phytophthora megasperma* var. *sojae*): Plants are attacked in all stages of growth. Symptoms in young plants are a soft rot and collapse of the root and stems. Seedlings are killed rapidly. Older plants first exhibit a yellowing of the lower leaves, the leaves wilt and the entire plant dies and turns brown. By the time the plant dies, the root system, with the exception of the tap root, has been almost completely destroyed. Damage is more severe on heavy clay soils than on light soils. Disease-free seed, crop rotation and plowing under plant residue are the most effective means of control. Certain in-furrow fungicides are registered for controlling this disease.

Purple Seed Stain (fungus - *Cercospora kikuchii*): A pink or light to dark purple discoloration of the mature seed coat provides easy identification. Size of the discoloration may vary from a small spot to the entire seed surface. Affected seed may be cracked, rough and dull. Seed quality is lowered. The causal organism attacks other plant parts and overwinters in diseased leaves and stems as well as in infected seed. Premature defoliation may occur when leaves are infected. When infected seeds are planted, the fungus grows from seed coats and infects seedlings. This serves as the primary source of inoculum. Wet weather during the growing season favors development of the disease. The fungus overwinters in diseased crop residue as well as on infested seed. Crop rotation, use of disease-free seed and burial of crop residue aids in holding the disease in check. Foliar fungicides are effective for controlling this disease.

Anthracnose (fungus - Colletotrichum dematium var. truncatum): The fungus infects stems, petioles and pods of plants nearing maturity. Dark brown or reddish-brown area may cover the surface of infected stems and pods. Lower branches die. Later, infected areas may become black with fruiting bodies of the fungus. Seed in infected pods may be shriveled and moldy or show no external sign of the disease. The fungus is carried over on the seed. Germinating seed may be killed before they produce a seedling. Dark brown sunken cankers develop on the cotyledons of young seedlings. The fungus also overwinters on infected plant residue. Use of disease-free seed, crop rotation and burial of crop residue reduce disease incidence. Seed treatment improves stand, but will not eliminate the fungus. Foliar fungicides are recommended for control.

Pod and Stem Blight (fungus - Diaporthe phaseolorum var. sojae): The pod and stem blight fungus attacks and kills older plants nearing maturity. The disease is identified by the numerous small, black fruiting bodies (pycnidia) appearing on stems and pods of infected plants. The pycnidia are arranged in linear rows on the stems and scattered on the pods. The fungus infects seed and causes them to be shriveled, moldy and smaller than normal. Seed may be infected, but appear normal. Seed infection is the most serious phase of the disease. When infected seed are planted, the embryo is often killed before emergence or the seedlings are killed at an early stage. Delayed harvest results in an increased incidence of the disease, especially if rain or humid weather and warm conditions prevail. Prompt harvesting when weather conditions permit and foliar fungicides are the most effective means of controlling this disease.

Stem Canker (fungus - Diaporthe phaseolorum var. caulivora): This disease was first discovered in Texas in 1984. Since its initial introduction in Chambers county in the southeastern part of the state it has spread to include Jefferson and Liberty counties. The disease is seed transmitted but once it becomes established in a field, the fungus survives in infected residue (primarily undecomposed stems). Spores are released from the residue in late spring/early summer and infect young vegetatively growing plants (V-4 stage or about 10-12" in height). The infection moves down the petiole and establishes a canker on the lower stem usually on the 2nd, 3rd, or 4th node of the plant. As the plant enters the reproductive stage (R4-R6), *the canker enlarges and girdles the stem.* This prevents pod-filling and yield loss on susceptible varieties can exceed 90%.

The first indication of stem canker from the turnrow is the appearance of yellowing leaves (R6-R7) showing an interveinal chlorosis. Plants exhibiting this symptom will show a slightly sunken brown area on the stem or base of a branch or petiole. The disease is usually scattered throughout a field when the field first becomes affected but in subsequent seasons, 80 - 90% of the plants may show symptoms when a susceptible variety is planted.

Recommended control measures include the use of resistant varieties in fields where stem canker has become established. Resistant varieties include Tracy, Braxton, and Dowling. A two-year-out rotation, delayed planting and plowing under crop residue may also reduce disease severity when planting moderately resistant or moderately susceptible varieties. The use of disease free seed and uncontaminated field equipment are suggested in areas of the state where stem canker has not yet become established.

Cotton Root Rot (fungus - Phymatotrichum omnivorum): Plants die suddenly during the summer. Affected plants are easily pulled from the soil and have buff colored fungal strands on the lower stems and roots. (For additional information, see Section on Cotton Root Rot.)

Brown Leaf Spot (fungus - Septoria glycines): This is the earliest foliar disease to appear on soybeans in the spring. Angular reddish-brown spots that vary in size from a pinpoint to 1/5 inch may appear on the first pair of leaves. Infected leaves turn yellow and fall prematurely. In severely infected fields, the lower half of the plant may lose all its leaves. The extent of defoliation depends on weather conditions following initial infection. Stems and young pods may also become infected. The disease may be seed-borne. The fungus overwinters on diseased stems and leaves. Warm, moist weather and poor drainage favor the spread of the disease. Control measures include use of disease-free seed, crop rotation, deep burial of crop residue and use of foliar fungicides.

Frogeye Leafspot (fungus - Cercospora sojina): This disease usually appears late in the growing season. The fungus infects leaves, stems and pods, but is most conspicuous on the leaf. On the leaf, it causes an "eyespot" lesion composed of a gray or tan central area surrounded by a narrow reddish border. Badly infected leaves fall prematurely. The fungus is seed-borne and causes weak seedlings. Control measures include planting disease-free seed, plowing under crop residue and rotation. Varieties vary in their resistance. Lee is a highly resistant variety.

Downy Mildew (fungus - Peronospora manshurica): First symptoms appear as indefinite yellowish-green areas on the upper leaf surface. Later, these areas become light to dark brown spots with yellow-green margins. Grayish downy tufts of mold growth appear on the lower surface. Severely infected leaves fall prematurely. The fungus grows within pods covering the seed with a white crust of spores. The disease is spread with infected seed and is carried over on plant debris. Practice crop rotation, use disease-free seed, and plow under plant residue.

Target Spot (fungus - Alternaria sp.): Infection primarily on leaves, but may also occur on pods and stems. Spots on leaves are reddish-brown, circular in shape and vary in size from a pinpoint to more than 1/2 inch in diameter. Large spots are composed of concentric rings. The fungus is generally considered a weak parasite which attacks plants too late in the season to cause serious damage.

Bacterial Blight (bacterium - *Pseudomonas syringae* pv. *glycinea*): Usually, one of the first diseases to appear on young plants. Small, angular spots varying from yellow to brown develop on leaves of infected plants. The brown area is usually surrounded by a water-soaked margin. Spots later dry and portions of the leaf drop out. Leaves may have a torn, ragged appearance. The disease may occur on stems and pods. Cool, wet weather favors development of the disease. This disease is seed-borne and the bacteria may overwinter in crop residue. Plant disease-free seed. Bury crop residue and rotate with non-susceptible crops.

Bacterial Pustule (bacterium - *Xanthomonas campestris* pv. *phaseoli*): Primarily a disease of leaves, although it may infect pods. First symptoms are small, yellow-green spots with reddish-brown centers on the upper leaf surface. The central portion of each spot appears slightly raised and develops into a small pustule, especially on the underside of the leaf. Several infections on the same leaf produce a large, yellow to brown area with small, dark brown spots. The brown, dead areas on older leaves may break up and cause a ragged appearance. In later stages, the pustules rupture and dry. When rupturing and drying occur, it may be difficult to distinguish this disease from bacterial blight. Severe infections cause defoliation. The disease overwinters in infected plant debris and is carried over to some extent on infested seed. Crop rotation, resistant varieties and burial of crop residues are the most effective methods of disease control.

Bud Blight (virus - tobacco ringspot virus): The most serious virus disease of soybeans. The first symptoms occur on young plants; a curling and browning of the terminal bud forms a crook. The bud becomes dry and brittle, and the leaf immediately below it shows a flecking of rusty brown specks. Later buds die and the plant is stunted and produces no pods or small, underdeveloped ones. These plants are known as "duds" and are easily recognized in the fall because they remain green after normal plants have matured. Plants infected later in the season may produce poorly filled pods that drop prematurely or they may be covered with purple blotches and remain on the plant. The disease usually appears first at the edge of a field and progresses inward, suggesting an insect vector. These is no known control measure.

Soybean Mosaic (virus): The most common virus disease occurring in Texas. Leaves of infected plants show a yellow vein clearing that develops in the small, branching veins of developing leaves. Infected leaves are narrower than normal with margins turned down. Margins later become ruffled and blistering occurs along the veins. Leaves become leathery in appearance, coarse and brittle. Symptoms become masked under higher summer temperatures. Infected plants produce misshapen pods and fewer seed than normal. The virus is carried in the seed and is transmitted by aphids. No control is known.

Bean Pod Mottle Virus (virus): Symptoms first occur in the primary leaf stage. The virus causes a yellow-green mottling that may fade and reoccur later in the growing season. Cool weather enhances disease development. The virus is transmitted by the bean leaf beetle. No control is known.

Root Knot Nematode (Meloidogyne spp.) Soybeans are attacked by all four species of root knot nematodes. See section on Nematodes (Root Knot).

Soybean Cyst Nematode (Heterodera glycines) The soybean cyst nematode (SCN) is the most serious pest of soybeans in the United States. To date, SCN has been observed in the state only in Northeast Texas (Bowie and Red River counties) and on the High Plains (Hale, Floyd and Swisher counties).

Symptoms of SCN can be easily confused with nutrient deficiencies, herbicide injury and other disorders. Plants are typically stunted in patches within an affected field. The degree of damage depends upon the initial numbers of nematodes present, the degree to which the environment favors reproduction within a season, and the susceptibility of the soybean variety grown. Damage to soybeans from SCN can be managed using resistant varieties, nematicides, and rotation. If SCN is suspected, a soil sample collected from the damaged area should be submitted to the Plant Nematode Diagnostic Laboratory.

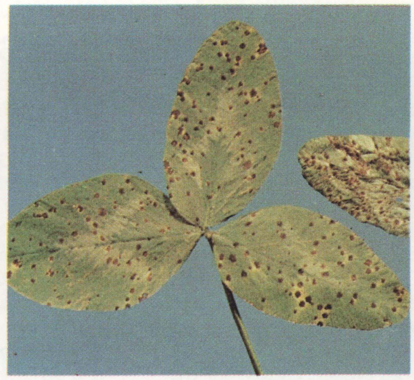
Rhizobium - Induced Chlorosis: A chlorosis or yellowing ranging from light green to nearly white may occur about 6-8 weeks after planting when the plants are making rapid growth. This chlorosis is more apparent in the top 2-3 leaves and is caused by lack of nitrogen. This condition is caused by an insufficient amount of nodule-forming bacteria. The chlorosis is usually temporary and plants appear normal by flowering. There is usually no yield reduction. Correct application of inoculum will prevent this situation.

Consult the Chemical Control Supplement (B-1140A) for specific control suggestions.

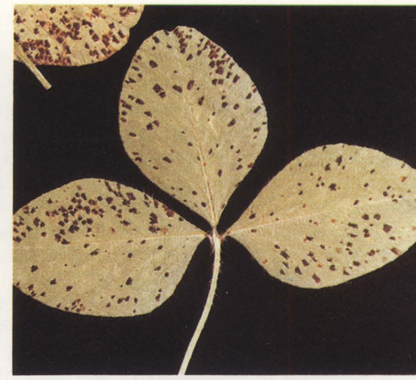
[Blank Page in Original Bulletin]

CLOVER DISEASES I

1. Stemphylium leaf spot or Target spot



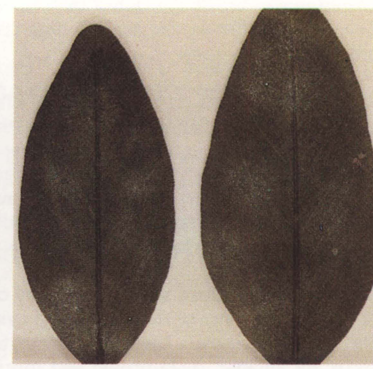
2. Common or Pseudopeziza leaf spot



3. Sooty blotch

4. Cercospora leaf spot

5. Bacterial blight or bacterial leaf spot



6. Powdery mildew

7. Red clover vein mosaic

8. Alfalfa mosaic

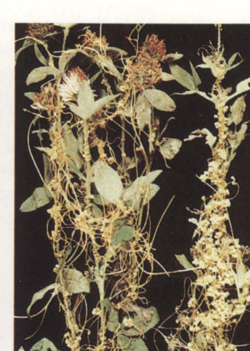
9. Northern anthracnose

10. Root rot

11. Root and crown rots

12. Fusarium root rot or Common root rot

13. Internal breakdown



14. Dodder

PLANT DISEASE NO. 11
JULY 1982
URBANA, ILLINOIS

CLOVER DISEASES I

1. **Stemphylium leaf spot or Target spot**, caused by the fungi *Stemphylium sarcinaeforme* and *S. botryosum*, is a common warm, wet weather disease of red clover. Losses are greatest in dense stands in late summer and autumn. Small dark brown spots on the leaflets later enlarge and develop into oval-to-round, target-like spots with alternate light and dark brown rings. Entire older leaves become wrinkled and dark brown with a sooty appearance. Such leaves usually remain attached to the plant. Elongated, sunken brown lesions with light centers may occasionally form on the stems, petioles and pods. The causal fungi overwinter in infected plant residue.

2. **Common or Pseudopeziza leaf spot** of red clover, caused by the fungus *Pseudopeziza trifolii*, is closely related to those causing common leaf spot and yellow leaf blotch of alfalfa. Infections are widespread during cool, wet weather. Very small, angular to round, dark spots--olive to reddish-brown, purple or black--develop on both leaf surfaces. Occasionally, small elongated dark streaks may occur on the petioles. Severely infected leaves may become yellow. The fungus overwinters in crop debris.

3. **Sooty blotch**, sometimes called black blotch, is a widely distributed disease of red clover caused by the fungus *Cymadothea trifolii*. Olive-green dots appear on the lower leaf surface, enlarge, become thicker and darker, and eventually resemble velvety, black, elevated cushions. In the fall, the black areas have a shiny surface. If infection is severe, the entire leaf turns yellow-to-brown, dies, and drops early. The fungus overwinters in plant residue.

4. **Cercospora leaf spot**, sometimes called summer black stem, is a widespread disease of red clover during warm, moist weather in summer and early autumn. It is caused by the fungus *Cercospora zebrina*. Leaf spots are angular, deep brown and more or less delimited by the veins. Older spots may develop ash-gray centers. Sunken, dark brown lesions on the stems and petioles may enlarge and merge to form extensive dark areas on the stems. The disease is spread by planting infected seed. The fungus also overwinters in crop debris.

5. **Bacterial blight or bacterial leaf spot**, caused by *Pseudomonas syringae*, is a minor disease of red clover. During cool, wet weather at any time during the growing season angular, dark brown-to-black blotches may form on the leaflets, petioles, stipules, stems, and flower pedicels. During wet weather, a milky-white bacterial exudate may form on diseased areas. The exudate dries to form a thin, crusty film that shines in the light. Infected leaves may become tattered and torn as the wind tears away the dead areas. The bacterium overwinters in infected residue and is spread by splashing rain and equipment.

6. **Powdery mildew** occurs wherever red clover is grown. It is most severe during long periods of dry weather when nights are cool and days are warm. The disease, caused by the fungus *Erysiphe polygoni*, can reduce both yield and hay quality, especially late in the growing season. A dusty, white to pale gray mildew grows in patches on the leaves. Infected leaves may turn yellow and wither prematurely. The mildew fungus overwinters as black specks (cleistothecia) scattered on diseased plant residue. It is spread by air currents.

7. **Red clover vein mosaic** is caused by a virus and is transmitted from plant-to-plant by the pea aphid (*Macrosiphum pisi*) and other aphids as they feed. The first symptom is a faint yellowing of the leaf veins. The chlorosis gradually intensifies until the veins and adjacent tissue may become a whitish-yellow. Symptoms are most conspicuous in young leaves during cool weather. Symptoms become "masked" or disappear during hot weather. Yields are reduced and affected plants are weakened and more susceptible to root rot fungi, winter injury, and drought. In time, clover stands thus become thin and unproductive.

8. **Alfalfa mosaic** is a virus-caused disease, transmitted from diseased alfalfa, red clover, or other legume plants to healthy plants by various species of aphids. A systemic light and dark green or yellow mottling is the most common symptom. Other symptoms may include vein yellowing, leaf crinkling and distortion, and yellow streaks or blothes on and between the veins. Legumes, especially garden peas and beans, growing near clover or alfalfa fields, commonly serve as reservoirs for mosaic viruses--alfalfa, red clover vein, bean yellow, and pea common. The viruses overwinter in a wide range of perennial host plants.

9. **Northern anthracnose**, caused by the fungus *Kabatiella caulivora*, is a serious disease of red clover in cool, wet weather. Elongated, dark brown to black, sunken, girdling lesions on the leaf petioles and stems cause the shoot tips and flower heads to droop (like a shepherd's-crook) or collapse. The lesions are later light colored with dark margins. The leaves on affected plants wilt, appear scorched as if by fire, become very brittle, and hang on for some time. The anthracnose fungus may be carried on or within the seed; it also overwinters in plant residue.

10. **Root rot** may be caused by one of several soil-borne fungi. Fungus growth is found in the crown-root area and within ruptured or otherwise injured tissues. Irregular, brown-to-black decayed areas may develop or the whole crown and upper taproot may disintegrate. Root rot is most conspicious in early spring. This disease complex causes a greater loss than all other diseases of red clover combined.

11. **Root and crown rots** affect all types of clover. This disease, caused by a complex of soil-borne fungi, acting singly or together, may cause a 50 percent loss of red clover plants during the first year. Diseased plants are generally yellow to bleached, stunted, and often wilt during hot dry weather. Such plants gradually decline in vigor; finally wither and die.

12. **Fusarium root rot or Common root rot**, is caused by several species of the fungus *Fusarium*. Like other crown and root rots, infection usually occurs to plants weakened by winter injury, prolonged drouth, low or unbalanced fertility, insect or nematode injury, improper management, mechanical injuries, or other diseases. Affected plants appear unthrifty, stunted, yellowish and wilt during hot, dry weather. Plants may be killed at any stage of growth but stand loss is greatest during the second year. A spongy or soft, light brown, reddish brown, or dark brown internal and external decay develops in the larger roots. The smaller feeder roots are also decayed, and appear "pruned off." The causal fungi are common soil inhabitants and are generally distributed wherever red clover is grown.

13. **Internal breakdown** is common in winter-injured crown and root tissue of red clover and other clovers. Crown buds are damaged or killed. This tissue is later invaded by fungi and bacteria resulting in serious crown and root rot losses. The control is to grow well-adapted species and varieties in a well-drained, fertile soil. **Avoid:** overgrazing and overcutting in the fall, rank growth, and excessive rates of fertilizer (especially nitrogen).

14. **Dodder** (*Cuscuta* spp.) is a slender, twining, parasitic vine that occurs in tangled, yellowish-orange patches that "pull down" clover plants. Dodder infects a wide range of crop plants, being especially common and damaging to clovers and alfalfa. Dodder seed is very difficult to separate from clover seed.

For chemical control suggestions, a listing of resistant varieties, and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.

Photo credits: A. Williams (1L), N. A. Smith (1R), University of Wisconsin (2, 3, 4L, 5, 7, 8, 9L, 10, 11, 14), W. W. Willis (4R), K. T. Leath (6, 12, 13), and D. Wysong (9R).

ALFALFA AND SWEET CLOVER

Medicago sativa and Melilotus indica

Cotton Root Rot (fungus - Phymatotrichum omnivorum): This disease occurs in heavy alkaline soil but is not a problem in the High Plains and Panhandle areas. Areas of dead plants occur in fields, usually in a circular pattern. Brownish, fuzzy strands of the fungus often appear on affected roots. The bark is dead and rotted on the tap root. When affected plants are pulled, they usually break off easily at or near the soil surface. It occurs in warm weather following rain or irrigation. (See section on Cotton Root Rot.)

Root and Crown Rot Complex (fungi and bacteria - Fusarium spp., and others): This is one of our most troublesome alfalfa and clover diseases. Stand decline is the most noticeable symptom. Decline usually begins during the second year after planting and gradually becomes more severe. Early symptoms include yellowing and wilting of stem tips or entire shoots which eventually die. Plants are normally stunted and have an increased number of small, shortened stems and small leaves. Roots may be rotten or simply have a few discolored lesions. Reddish-brown streaks are usually evident when the outer bark is removed. Rotting may occur only at the crown area of the plant. Control is difficult. Use of resistant alfalfa varieties such as Mesilla and Zia is often the best method of control. Do not allow water to stand in a field for extended periods.

Seed Rot and Seedling Disease: Several soil fungi may attack seed as it germinates or may attack the young seedling after it has emerged from the ground. If the seedlings have emerged, the disease is characterized by a soft, watersoaked area on the stem just below the soil line. Severe stand reduction can occur. This problem is most common when the soil is excessively wet. Chemical seed treatment may help reduce stand losses.

Alfalfa Stem Nematode (nematode - Ditylenchus dipsaci): The stem nematode has caused reduced yield in only a few Texas fields. Symptoms include shortened stems which become thickened and club-like. Crown buds infested with nematodes become swollen and distorted and will break off easily. The stem nematode is active only under cool, moist conditions. Plants grow normally during warm weather. Nematodes are introduced into fields by planting poor quality, nematode infested seed and by allowing run off water from infested fields to drain into other fields. Lahontan variety is resistant and is recommended in fields that have previously been infested with stem nematodes. A rotation with sorghum or small grains is also beneficial.

Wilt Diseases (bacterium - Corynebacterium insidiosum): Water conducting tissues in stem, crown, and roots appear brown to black. Plants are yellow and dwarfed. Stems are more numerous with bacterial wilt. Plants die after several months. The fungus enters the plant roots and may live in the soil many years. Apply potash according to soil tests. Use crops other than legumes in the rotation for three to four years. Buffalo and Ranger are resistant to bacterial wilt. They are adapted to the Panhandle.

Downy Mildew (fungus - Peronospora trifoliorum): This disease is often seen in the spring when cool, moist weather exists. It may cause serious reductions in yield. The fungus, which causes new growth to turn yellow and new leaves to be twisted, infects that plant systemically for life and can remain in soil on old plants for several years. A white moldy growth is usually present on the underside of diseased leaves. Where severe, cut early to save as many leaves as possible. Prevention is possible by using clean, certified, and treated seed to establish new stands. Practice long rotations when the fungus is present.

Rust, Leaf Spots, and Stem Blight: Several species of fungi often cause leaf and stem spots on alfalfa but are not considered to be serious problems. Small, brown to black circular spots on the lower leaves are the most noticeable symptom. Some of the lower leaves may turn yellow and drop. The disease can develop rapidly when moist conditions exist.

Mosaic (virus): Alfalfa mosaic is a widespread virus disease carried by insects, but it has never reached epidemic proportions. Light and dark streaks and blotches in the leaves are the main symptoms. Some stunting may occur. No special control is practiced in alfalfa.

Dodder (parasitic plant - Cuscuta planiflora): This yellowish parasitic plant that has no leaves twists around the stems of host plants. Suckers or haustoria of dodder penetrate the host tissue and withdraw nutrients for their own use. It usually occurs in spots in the field. Seed produced by dodder are similar in size and color as those of alfalfa. This is how the plant usually becomes distributed from one area of the county to another. Seed fields should be screened carefully for occurrence of this parasitic plant and infested areas should be burned prior to harvest.

PRODUCTION PRACTICES WHICH REDUCE DISEASES

Prepare land before planting so the field has a uniform slope without low spots. A firm seed bed free of clods is necessary to get a good stand.

Plant resistant varieties - Selecting the right variety is probably the most important decision to make in producing alfalfa. Resistant varieties offer the greatest protection from diseases as well as insects and nematodes. Mesilla and Zia are good yielding varieties resistant to root and crown rot complex (bacteria and Fusarium wilt). They are also resistant to the spotted alfalfa aphid, and Mesilla is resistant to the green pea aphid. New Mexico 11-1 and Ranger are acceptable varieties with moderate resistance to the root rot organisms. Lahontan is recommended if the alfalfa stem nematode is a problem. It also has resistance to the spotted alfalfa aphid.

Plant certified seed to insure getting pure seed of the desired variety.

Treat seed with a fungicide such as thiram or captan to help prevent seed rots. Seed treatment often makes the difference between getting a good thick stand or a poor stand.

Inoculate seed with nitrogen-fixing bacteria to increase yield and growth of alfalfa if planted on new land and or on land that has not had alfalfa on it for several years.

Plant in the fall to get the crop off to a better start. Fall planting is preferred because the seedlings usually have fewer weeds to compete with, and most weeds die with the first frost.

Use the correct amount of fertilizer to obtain a healthy, vigorous, high yielding crop. Twenty pounds of nitrogen at planting time helps the seedlings get established while nodules are developing on their roots. Alfalfa is a high user of phosphorus and responds well to this element in most areas of the state. Apply 90 to 120 pounds of P_2O_5 depending upon a soil test.

Irrigate properly - Alfalfa requires a lot of water to yield well. Alfalfa yields are higher, and it is less susceptible to root and crown rot diseases if light, frequent irrigations are used. Good drainage is needed.

Cut during the early bloom stage to obtain high quality of hay. Early cutting helps prevent leaf diseases since tall, rank growth favors disease development. Early cutting also reduces losses of leaves when rust, downy mildew, and leaf spot diseases are developing.

Plow out thin stands of alfalfa when unprofitable. Alfalfa fields should be rotated to small grains, sorghum, or some other crops for at least two years before seeding back to alfalfa.

AUSTRIAN WINTER PEA AND SINGLETARY PEA

Pisum arvense and *Lathyrus hirsutus*

Scab - (fungus - *Cladosporium herbarum*): Black spots form on pods, stems and leaves. It usually is more severe where these crops are continuously cropped in the same field. Rotate with crops such as wheat, oats, or barley. No fungicides are approved for use on these crops.

Anthracnose (fungus - *Colletotrichum pisi*): Small circular to irregular shaped spots are formed on leaf and pod tissue. See conditions for development and control procedures listed under scab.

Powdery Mildew (fungus - *Erysiphe polygoni*): A white, powdery growth forms on leaf surfaces. Affected leaves turn brown and shed from the plant. The problem is usually more severe under cool, dry conditions. No fungicides are cleared for use. Seed producers might want to investigate chemical control possibilities if the hay is not going to be used for livestock feed.

Seedling Disease (fungi - *Rhizoctonia solani*, *Pythium* spp., *Fusarium* spp., and others): Seedling disease or damping-off is caused by soil organisms that are predominately fungal in nature. When they are present in high populations and conditions are especially favorable for their development, severe stand losses can occur. If the problem occurs consistently, a producer should consider using a suitable seed treatment fungicide.

Root Knot Nematodes (nematode - *Meloidogyne* spp.): Since these crops grow during the cool season, little reduction in plant growth generally occurs. Since nematodes develop most rapidly when soils are warm, the problem is more likely to be observed during the latter part of the growing season. This may create a serious problem for the following crop if it is susceptible. For example, tomatoes or sweet potatoes following nematode damaged peas would be ill advised.

Dodder (parasitic plant - *Cuscuta* spp.): This parasitic plant is pale yellow in color and wraps itself around the host plant. For more detail, see the Dodder section.

BERMUDAGRASS

(Includes Common, Coastal, and other Improved forage species)

Cynodon dactylon

Fading out (fungus - "Helminthosporium" sp. and other fungi): This condition is most likely to occur when the grass is in a weakened condition due to certain growth requirements not being met. This occurs commonly in coastal Bermudagrass when potassium levels are low in the soil. This is a common problem in the deep, sandy soils of East Texas. To avoid this problem, growers should fertilize properly with a complete fertilizer, avoid overgrazing or ill timed cutting, and prevent the development of thatch at the base of the plant.

Rust (fungus - Puccinia cynodontis): Rust is an occasional problem that usually results in little damage. Occasionally, minor diseases become severe when certain factors are right for organism development. When rust occurs on forage Bermudagrass, it should be immediately cut for hay or grazed heavily. This will remove the heavy canopy that favors the retention of high humidity. There is no evidence that these rust fungi produce toxins that would be damaging to livestock. Data on variety reactions are not available, but limited observations indicate that Alcia and Callie are much more susceptible than other varieties.

Brown Leaf Blight (fungus - Colletotrichum graminis): This disease is more likely to occur in Southeast Texas during August on coastal Bermudagrass. Grayish brown to dark brown streaks occur on leaf blades. No chemical control is recommended.

Smut (fungus - Ustilago cynodontis): Smut occasionally occurs on common Bermudagrass but is not known to reduce forage production appreciably. It becomes apparent only when plants form seed heads that are colonized by the smut fungus. Control is not required.

Nematodes (nematode - Pratylenchus spp. and other): Common Bermudagrass is considered to be more susceptible to nematode damage than coastal and other improved forage types. If nematode damage limits growth of common Bermudagrass, one should sod with an improved forage type, preferably Coastal.

GRASSES (FORAGE)

Several species

For Lawn and Turf Diseases - See Section on Lawn and Turf Diseases.

Seed Rot and Seedling Blight (fungi - *Pythium* spp., *Fusarium nivale*, *Rhizoctonia* sp., *Helminthosporium* sp., *Fusarium* spp.): Germinating seed of all grass varieties may be attacked and rotted. Small sprouts may be killed before or soon after they come through the soil by the same fungi that cause seed rot. Where the problem has been serious, treat seed. (See seed treatment.) Avoid planting too deeply.

Root Rot and Crown Rot (fungi): Most fungi that cause seed rot and seedling blight are involved. Yellow to brown discolorations appear on affected root and crown tissue. The lower leaves may become yellow and die, and finally, nearly all infected plants either die or are retarded severely. Weakened plants are killed by short periods of drought or winter injury. Control is the same as for seed rod and seedling blight. Use good management practices.

Powdery Mildew (fungus - *Erysiphe graminis*): White to gray mold growth develops either in blotches or uniformly over the entire leaf surface. Dried out areas of dead leaf tissue may develop and kill the whole leaf. Severely infected plants may become weakened and die. In pastures where the grass is either closely grazed or cut, the symptoms are not as conspicuous. On ranges and pastures, control methods are impractical. For grass nurseries and grass crops for seed production, see Chemical Control section. Grasses most severely affected by powdery mildew are wheat grasses (Agropyron), bent-grass (Agrostis), fescue (Festuca), and bluegrass (Poa). Common rescuegrass is very susceptible. Other strains of rescuegrass seem more resistant. The disease is apt to be more severe during cool weather with frequent showers or following application of irrigation water.

Ergot (fungus - *Claviceps* spp.): Dark brown to nearly black, spurlike bodies (sclerotia) extend beyond the floral bracts in diseased florets. One to many ergot bodies may develop in a single head. When grass matures, most of the sclerotia drop to the ground. They be harvested with hay or seed or consumed by grazing livestock. Ergot in Dallisgrass is prevalent in Southeast Texas. Occasionally, it can be found on Bahiagrass. The disease affects production of grasses very little, but it does have serious consequences on livestock that feed on diseased grass. When ergot is consumed in quantities too small to manifest pronounced symptoms of ergotism, it affects the general health and vigor of the animals. When ergot is consumed in considerably larger quantities over a long period, ergot results in either spasmodic or gangrenous ergotism. In the latter phase of the disease, hoofs, tips of ears, and tips of tail may slough, teeth may drop out, and hair may shed excessively prior to death. There is no effective control on host plants. The following will help to avoid losses of livestock due to ergotism: Employ a crop rotation where none of the host plants follow each other. Do not plant ergot-infested seed. When ergot appears in pastures, either clip the heads or wait until the grass matures and the sclerotia have fallen to the ground before using it for grazing purposes. Mowing borders and fence rows before heading will help eliminate secondary infestation. The disease is sometimes worse in these areas. Do not harvest ergotized crops for hay. Removal of sclerotia from ergotized cereal or grain prior to feeding it, is essential to avoid the ergot disease of livestock. To make ergotized grains safe for feeding, the sclerotia should be removed by the brine sedimentation process. By this method, the ergotized grain should be placed in a vat of salt solution (4 pounds in 25 gallons of water). When the grain is stirred, the sclerotia rise to the surface and can be skimmed off. Destroy screenings and skimmings. Grain treated by this method should be dried before storing.

Leaf Rust (fungus - Puccinia spp.): See leaf rust of oats and wheat for description. Many different leaf rusts damage grasses.

Brown Leaf Blight (fungus - Colletotrichum graminis): Apt to occur in Southeast Texas during August on coastal Bermudagrass. Grayish brown to dark brown streaks occur on leaf blades. No chemical control is recommended.

Nematodes other than Root Knot: (See section on Nematodes other than Root Knot.)

LESPEDEZA

Lespedeza striata

Root Knot Nematode (nematode - *Meloidogyne* spp.) The Rowan variety i resistant to some species of root knot nematodes. Nematicide application are neither cleared nor practical for pasture applications. Species o nematodes other than root knot may affect this crop and cause stunting a well as loss of stand.

Dodder (parasitic plant - *Cuscuta* spp.): This small, light yello parasitic plant wraps itself around the stems of lespedeza plants. I produces suckers or haustoria that penetrate the host tissue and serve t extract nutrients from it. When it occurs in a localized area, a burnin device such as a prickly pear burner can be used to eradicate the plant.

Leafspot (fungi - *Colletotrichum* spp. and other fungi): Although leafspot occur, they seldom become a limiting production factor. Stands heavil spotted should be cut or grazed to remove inoculum potential.

VETCH

Vicia sativa

Anthracnose (fungus - *Colletotrichum* spp.): Brown to dark black spots appear on leaves and stems. Defoliation along with stem girdling causes plant death in rank growth. The problem is more severe in wet years. The organism is seed borne and is carried over in crop residue. Avoid planting on poorly drained soil and rotate with unrelated crops.

Root Knot Nematodes (nematode - *Meloidogyne* spp.): Most vetch varieties are highly susceptible to root knot nematodes. If planted on infested fields some stunting and plant death may result. An increase in the nematode population may also cause severe damage on susceptible crops grown later. Cahaba White is a variety resistant to *Meloidogyne incognita* but not other root knot species.

Powdery Mildew (fungus - *Erysiphe polygoni*): Powdery mildew is an occasional problem that occurs during cool, dry periods. Some defoliation may occur in heavy vine growth. No fungicides are cleared for use.

Consult the Chemical Control Supplement (B-1140A) for specific control suggestions.

SUGAR BEET

Beta vulgaris

Leaf Spot (fungus - *Cercospora beticola*): First symptoms are small, whitish spots scattered over the surface of older leaves. The spots increase in size, becoming brownish or purplish in color. Individual spots are usually circular but several may coalesce into larger areas of dead tissue. Mature spots, about 1/4-inch in diameter, become gray as the fungus produces spores. Leaves may become yellow and die. As leaves die, the crown becomes cone-shaped with a rosette of dead leaves at the base. The fungus overwinters on dead leaves and attacks other beets, lambsquarter and mallow. The disease develops rapidly when day temperature is 80 to 90°F. High humidity and a susceptible variety are conducive to severe epidemics. Control is accomplished through long rotations, resistant varieties and through preventive fungicide applications.

Crown and Root Rots (fungi - *Rhizoctonia* spp., *Fusarium* spp., *Phoma* sp., *Phytophthora* sp., *Sclerotium rolfsii*, *Phythium* sp., and several others): Crown rot and root rot appear as a wilting of leaves followed quickly by death. Roots have dark rooted areas and develop a strong odor in some cases. The rot starts at injured sides and at the crown. Disease is worse when plants suffer from water stress during the growing season. Control is accomplished through long rotations and proper use of fertilizer and irrigation to maintain uniform moisture.

Powdery Mildew (fungus - *Erysiphe polygoni*): This disease first appeared in 1974 on the Texas High Plains. A white powdery growth develops on the leaf surface. Severe infection causes reduced yield and decreased sugar content. Control by regular spray programs using sulfur fungicides.

Other Diseases: Curly Top Virus is a serious problem on sugar beet. (See separate section on this disease.) Nematodes cause serious losses in other beet production areas. Their control is also discussed separately.

SUGARCANE

Saccharum officinarum

Mosaic (virus): This disease causes the destruction of chlorophyll in the green portions of the plant. Leaves of infected plants have chlorotic or light-colored areas, sometimes, depending on varieties, elongated into more or less irregular stripes or streaks which are surrounded by areas of normal green color. In general, islands of dark green color are set in a background of light green or yellowish areas, this being the most common symptom of the disease. The symptoms are most noticeable in young leaves, which are those in the spindle; symptoms may disappear or become difficult to recognize as the plant matures. Infected plants grow slowly, have a general yellow color and yield poorly. However, varieties react differently and some tolerant varieties yield adequately even though infected. Infected stalks used for seed will produce diseased plants. The virus can also be transmitted from diseased to healthy plants by insect vectors and by mechanical inoculation. Several species of aphids are known to transmit the virus, such as the corn leaf aphid, greenbug, and the sowthistle aphid. The disease is best controlled by using resistant varieties and planting mosaic-free seed. Sugarcane fields to be used for seed should be rogued several times when plants are small to eliminate mosaic-infected plants. If the percent infection is high, these fields should not be used as source of seed.

Ratoon Stunting Disease (RSD) (bacterium): Diagnostic symptoms of ratoon stunting disease are not manifested externally; therefore, the diagnosis of this disease is very difficult. Affected plants are stunted and unthrifty, but these symptoms can be caused by several other factors. Planted cane usually is not affected, but ratoons of diseased cane are slow to start growth and can be severely stunted. An internal discoloration of diseased stalks has been used as a means of diagnosing RSD: split infected stalks show a pink or orange color in the lower portion of the node. However, other factors can result in similar discoloration. The bacterium is transmitted in infected seed pieces, and can also be spread in the field by mechanical means, such as the cane knife. Control is achieved by using healthy planting material, preventing the spread of the disease in the field, and by using resistant varieties. Sugarcane fields to be used for seed should be inspected periodically in an attempt to detect the disease. The best procedure is to maintain a RSD-free source of seed. For this purpose, cane to be used for seed should be treated with hot water at 50°C (122°F.) for two to three hours to destroy the bacterium. Afterwards, this cane is planted, increased and maintained disease-free to serve as a reservoir of healthy seed.

Red Rot (fungus - Colletotrichum falcatum): The fungus may infect any part of the sugarcane plant; however, the disease causes the greatest damage to the seed piece, resulting in poor germination and weak plants that are low in sucrose content and yield poorly. Stalks, when split longitudinally, show reddening of the tissues and vascular bundles. Under periods of cold weather and high humidity, the entire seed piece may rot, resulting in light stands and skips. On the leaves, the fungus causes elongated lesions in the midrib that are bright red at first, but later become dull gray, with red margins. Black masses of the fungus can sometimes be seen in the center of the spot. The use of resistant varieties is the most important means of controlling red rot. Planting early, good seed bed preparation and the use of good quality seed are other means of reducing losses.

Pineapple Disease (fungus - Ceratocystis paradoxa): The fungus infects the seedpiece, affecting mainly the central core of the stalk, causing the affected tissue to become red at first and later turning black. During the early stage of infection, a faint odor may be given off when the stalk is split in half that resembles that of fresh pineapple. The fungus gains entrance to the seed piece through the cut ends, growing rapidly in the internode and slowly in the nodal regions. If conditions are favorable, the entire seed piece is destroyed. This results in weak germination and poor stands in the fields. Conditions that retard the quick germination of seed cane favor the disease. Control can be obtained by using cultural practices that will result in fast germination of the seed. Other effective control has been treating the seed pieces with fungicides prior to planting.

Sheath Rot (fungi - Cytospora sacchari): The disease is found principally on the leaf sheath, but can also be found on other parts of the plant and on seed pieces. The affected leaf sheath is at first red, but later becomes dull gray in color. In these areas, the hard, black, raised fruiting bodies of the fungus develop and the surface of the sheath becomes rough and like a file to the touch. The disease is considered of minor importance; control practices are not justified.

Leaf Spots (fungi - "Helminthosporium" spp., Cercospora spp., Gloeocercospora spp.): Several leaf spot diseases of sugarcane are known to occur which are caused by a variety of fungi. These lesions or spots are usually small, bright red at first, but later coalescing into irregular, large patches. These diseases are not considered to be of major importance, and no control practices are necessary.

Banded Chlorosis (Physiological - Temperature): Symptoms consist of horizontal areas of yellow tissue extending across the leaf on both sides of the mid-rib. The color varies from a pale yellowish green to almost white. More than one band may be seen on the same leaf. This condition is caused by low temperatures, particularly a sudden drop in temperature. The severity of the condition depends on the suddenness and intensity of the drop in temperature. Chlorotic bands are observed several days after the change in temperature occurs.

Nematodes (Meloidogyne, Pratylenchus, Trichodorus, Tylenchorhynchus, Hoplolaimus): Several nematodes have been shown to be important parasites of sugarcane. Among these are: root knot, lesion, stubby root, and stunt nematodes. Symptoms associated with nematode damage are similar to those resulting from lack of nutrients, water stress, or inadequate root system. Some symptoms are stunting, wilting or chlorosis, root knots or galls, root lesions, stubby roots and surface necrosis. Diagnosis cannot be made on symptoms alone, but should be based on laboratory analysis of soil samples collected in problem areas. Nematodes living in undisturbed areas do not move very far by themselves; therefore, they must be spread by equipment, irrigation water, and in soil and roots of seed pieces. Control of nematodes, if warranted, is accomplished by fumigating the soil prior to planting. Nematicides are available that can be incorporated in the soil surface.

Smut (fungus - Ustilago scitaminea): A disease found a few years ago in Texas, smut affects sugarcane plants in a very noticeable way. Plants affected by smut produce an abnormal growth at the growing tip that resembles a whip. The growth is long, narrow and curved, often several feet in length. The surface of the whip is covered by a dark-brown to black mass of spores which makes disease identification rather easy. Affected plants are stunted, stalks are abnormally thin and lateral buds or eyes often germinate and grow, giving the whole plant a grassy appearance. Spores of the fungus which are abundantly produced on the whip can become airborne and in this fashion can travel long distances in air streams. Once introduced into a field either by airborne spores or by using contaminated seed pieces, the fungus becomes soil-borne, being able to perpetuate in a field for as long as a susceptible host is grown. The disease can be best controlled by replacing susceptible varieties with resistant ones that are adapted to the area. The development of resistant varieties is the only practical means of control. Other control practices that should be used to avoid introducing the disease into a field or spreading to other areas are the destruction of diseased plants as soon as they are found (if not too numerous); the treatment of the seed pieces with hot water, steam or hot air; and the use of seed pieces from non-infected areas.

SUGARCANE

Common sugarcane varieties used in the Lower Rio Grande Valley and their reaction to the most common diseases found in the area.

	Disease			
Variety	Mosaic	Rust	Smut	RSD
NCo 310	HS	R	HS	MS
CP 65-357	HS	MR	MS	MS
CP 70-321	MR	MR	R	MS
CP 66-315	MS	MR	MS	-
CP 68-350	HS	MR	MS	-
CP 71-1038	HS	MR	HR	-
TCP 81-3058	MS	MR	R	-

HR = Highly Resistant
R = Resistant
MR = Moderately Resistant
MS = Moderately Susceptible
S = Susceptible
HS = Highly Susceptible

Consult the Chemical Control Supplement (B-1140A) for specific chemical control suggestions.

AIR POLLUTION INJURY

Air pollution injury on plants has been carefully documented in recent years. In some areas, injury on certain species has been serious and has represented a limiting production factor. This type of damage is more noticeable, but probably not as great as the sub-lethal chronic injury that occurs over much larger areas. Chronic damage is more difficult to diagnose and evaluate. Diagnosticians should be aware that pollutants are mixed in the atmosphere and that these mixtures may produce symptoms that vary from those caused by a single compound under laboratory conditions.

Injury produced by certain pollutants along with sources is given as follows:

Pollutant	Source	Symptoms
Ozone	Nitrogen dioxide and hydrocarbons emitted from automobiles, industrial combustion, oil refineries and many lesser sources react with sunlight to form ozone. During electrical storms, ozone is produced and can be brought down from the upper atmosphere by strong down drafts.	Four different kinds of symptoms can result from ozone exposure. The most common symptom is localized thickening and pigmentation of the cell walls causing sharply defined small dot-like lesions. General upper surface bleaching is another common type of injury. Large bifacial necrotic areas ranging from white to red may develop if all the tissue through the leaf is killed. Some species show only general chlorosis or chlorotic mottling or chlorotic flecks.
Sulfur Dioxide	Emitted during combustion of many fuels, especially coal and petroleum. Also released during smelting operations.	Accumulation of sulfite in tissues produces a general chlorotic appearance of the leaf and a silvering or bronzing of the undersurface. Acute injury from absorption of lethal quantities of sulfur dioxide appears as marginal or intercoastal areas of dead tissue with a gray-green watersoaked appearance, which usually dries to a bleached ivory color but may turn brown, red or black. The necrotic areas may fall out and after much of the leaf is affected, it will shed.

Fluoride	Released from manufacturing processes involved in the production of aluminum, steel, ceramics and phosphorus chemicals and fertilizers.	Necrosis is the characteristic symptom of fluoride injury occurring on broad-leaved species at the leaf tips and margins where the fluoride accumulates. First sign of injury is a dull-green watersoaked discoloration of these tissues within 24 hours or several days depending on concentration. These watersoaked tissues turn light to dark brown within 48 hours during hot weather. Cool temperatures may delay symptoms as much as several days. Symptoms on needles of pine and other conifers consist of dead tissue beginning at the tip and progressing toward the base. Injured tissue first is chlorotic and turns buff to reddish-brown.
Nitrogen oxides Peroxyactyl Nitrates (PAN)	Produced by high temperature combustion.	Many plants develop a silvering of the lower leaf surface with PAN. Leaves of sensitive species develop a slightly oily or waxy appearance two to three hours after exposure. Glazed symptoms develop gradually with the advanced bronzing stage following after two or three days. Very young and the most mature leaves are resistant.

Many other substances may be released to the atmosphere and produce damage to plants. These include ethylene (usually from incomplete combustion), herbicides, chlorine gas, ammonia, particulates (such as heavy metals or sulfuric acid mist) and hydrogen sulfide. These all produce characteristic symptoms.

Plants vary in their susceptibility to different pollutants. This is indicated in the following chart:

Ozone

Sensitive - alfalfa, beans, oats, onion, peanut, potato, radish, spinach, tomato, petunia, grape, carnation and pine

Sulfur dioxide

Sensitive - alfalfa, bean, cotton soybean, sweet pea, verbena, zinnia, apple, pear, pine okra, spinach, turnip and sunflower

Fluoride

Sensitive - apricot, gladiolus, grape, peach, pine and tulip

Nitrogen oxides

Sensitive - azalea, bean, hibiscus, lettuce and sunflower

Those observing and diagnosing air pollution injury should be aware that many things may resemble symptoms produced by air pollutants. Care should be taken in diagnosis.

ALGAE

Green algae are the simplest of green plants. They are found everywhere and are numerous in any place where sufficient moisture is present to support their growth. They are commonly found on tree trunks, twigs, shrubs, soil, rocks and walls and can cause "scum" on ponds and poorly drained lawns. Their habit of growing profusely in evaporative coolers and on rock houses and sidewalks often makes them very bothersome. Although copper fungicides will do an excellent job for controlling algae, in most instances it is not always desirable. Certain forms of copper will severely stain houses and masonry work. Under these conditions, compounds cleared for use in swimming pools may be useful. Swimming pool compounds cannot, however, be used where desirable plants are growing. If all chemicals fail, an increase in the penetration of sunlight and a decrease in the level of moisture should correct the problem.

ASTER YELLOWS

Aster Yellow (mycoplasma): Aster yellows is a disease caused by a mycoplasma-like organism which attacks a wide range of plants. Plants may be stunted or with numerous secondary shoots. Foliage is yellow and seeds are usually sterile. Plants have an upright habit of growth. In many plants the veins of immature leaves are clear. Affected leaves are somewhat narrower than healthy leaves. Old leaves may develop a slightly reddish, brownish, or purplish tinge in the late stages. The main branches will be shortened. Flower parts may develop into leafy structures. In lettuce, the head leaves fail to fully develop and they have pink to tan spots. There is a curling and twisting of inner leaves. Infected plants may fail to head. In carrots, the tops become yellow, stunted, and bunchy. Many small rootlets are on the carrot. Onion leaves are twisted, yellow, more numerous and dwarfed. Small, purple, terminal leaves and auxiliary tubers develop on potato plants. Aster yellows affects 300 different species that represent more than 40 families of plants. The ones listed below are the most important.

Crops: broccoli, buckwheat, cabbage, carrot, cauliflower, celery, endive, flax, lettuce, onion, parlsey, potato, parsnip, pumpkin, red clover, salsify, spinach, strawberry and tomato.

Flowers: aster, anemone, calendula, Centaurea, China aster, chrysanthemum, Clarkia, cockscomb, Coreopsis, cosmos, delphinium, daisies, Gaillardia, hydrangea, marigold, Nemesia, Paris daisy, periwinkle, petunia, phylox, Scabiosa, snapdragon, statice, strawflower, veronica, and zinnia.

Weeds: cinquefoil, daisy fleabane, dandelion, horseweed, plantain, ragweed, thistle, wild carrot, and wild lettuce.

The mycoplasma overwinters in leafhoppers on perennial host plants. Leafhoppers can spread the mycoplasma 9 to 21 days after feeding on diseased plants. The mycoplasma multiplies in the insects and leafhoppers can spread the disease for 100 days or more after becoming infective. The ability of leafhoppers to transmit the organism is reduced when temperature is over 90°F. Overwintering of the mycoplasma occurs more often in some plants than in others because leafhoppers prefer to feed on those host plants. Symptoms show in plants in 10 to 40 days after insect feeding. The disease can be serious when dry weather forces leafhoppers to migrate from wild weeds to irrigated fields of susceptible plants. The six spotted leafhopper is one of the most common vectors in Texas, but at least twelve different species of leafhoppers may transmit the organism to healthy plants.

Control recommendations include the following: (1) Obtain healthy seed, cuttings and plants. (2) Early control of leafhoppers on lettuce and carrots. (3) Spray weeds surrounding field with insecticide according to current recommendations. (4) Apply insect control before cultivation, weeding, and other field operations. (5) Control weeds during the growing season in the field, on irrigation ditch banks and in surrounding areas. (6) Avoid rotations where one susceptible crop follows another. (7) Destroy volunteer overwintering plants and avoid planting near established diseased crops. (8) Destroy affected plants in small areas as soon as they appear to be diseased. (9) Screen small plantings with wire mesh to exclude leafhoppers if practical. (10) Always keep in mind the relationship between cultivated hosts, insect vectors and wild or alternate hosts and practice proper sanitation and good husbandry throughout the year to insure optimum growth of crop, plants and proper control of weeds and insects.

CHARCOAL ROT

<u>Charcoal Rot</u> (fungus - <u>Macrophomina</u> <u>phaseolina</u>): Many plants are susceptible to this soil borne fungus and symptoms vary according to type. Infected stem tissue shows evidence of shredding with tiny black dots (sclerotia) between the remaining tissues. This gives those plant parts an ashy-gray appearance. Stalks such as corn or sorghum show a shredded appearance when split longitudinally. Charcoal rot occurs most consistently when plants are experiencing moisture stress due to drought. The fungus is widely distributed and builds up in soil when susceptible host plants are present and conditions favor its development. Rotation with unrelated crops help reduce the population of the fungus in the soil. Avoid moisture stress by increasing the moisture holding capacity of the soil and, if available, using irrigation when needed. Rotate with crops that are not seriously affected by this organism. Practices which hasten decomposition of crop residue may help decrease the population of the fungus in the soil.

CHEMICAL DAMAGE

(Phytotoxicity)

Symptoms: Browning or yellowing of the leaf margins and brownish or discolored irregular areas on leaves are common symptoms of chemical burns. Severe injury may be evidenced by distortion of new leaves, or defoliation, but unless some serious mistake has been made, spray or dust injury is not an important consideration. Pesticides in emulsifiable formulations are more likely to cause foliage burn than wettable powders, particularly when combined with wettable powders.

Copper: Stone fruits are sensitive to copper. Bordeaux mixture causes russeting of apples and may stunt cantaloupe and watermelon leaves. Copper compounds should be used with caution on any cucurbit crop. Injury is most likely to occur when materials are applied to wet leaves and under damp, slow-drying conditions. Copper containing sprays will also defoliate peaches, plums and apricots.

Zinc Sulfate: This causes severe defoliation of fruit trees and should not be included in fruit sprays.

Sulfur: Frequent applications of sulfur may cause light foliage burn on rose and tender foliaged ornamentals when temperatures exceed 85°F. Sulfur should not be used on cucurbit crops such as squash and cucumbers.

Insecticides: Injury to plants may occur when materials are improperly applied or applied under adverse environmental conditions. Foliage burn is most likely to occur when materials are applied to wet foliage or when extremely high temperatures follow application.

Herbicides: Severe injury to foliage may result from spraying plants with equipment contaminated by previous use with hormone type herbicides. Common symptoms are severe growth abnormalities of leaves and leaf roll. Some herbicides are taken up by plant roots and cause a marginal burn. This burn develops inward to the veins of the leaf as the material is concentrated. Defoliation eventually occurs. New leaves are then formed which may also burn and defoliate. This will continue until the plant either dies or the chemical is no longer present in a toxic level in the root zone. Equipment used to apply herbicides should be well marked and should not be used for disease or insect control purposes. Some trees and certain ornamentals are sensitive to herbicides that are blended with fertilizers.

COTTON ROOT ROT

Fungus - Phymatotrichum omnivorum: This disease is also known as Phymatotrichum root rot, Texas root rot and Ozonium root rot. It is caused by one of the most destructive fungal plant disease organisms that can attack more than 2,000 species of plants. However, monocotyledonous plants (grasses, etc.) have field resistance. In Texas, the disease is economically important in cotton, ornamentals and fruit, nut and shade trees. The fungus is prevalent in calcareous clay loam soils with a pH range of 7.0 to 8.5 and in areas with high summer temperatures. Therefore, the disease is limited to the Southwestern United States.

Cotton root rot has been reported in Texas counties from the Red River to the Rio Grande and from Tom Green County to the Neches River.

DISEASE SYMPTOMS - Symptoms are most likely to occur from June through September when soil temperatures reach 28°C (82°F). The first symptoms are slight yellowing or bronzing of the leaves. The upper-most leaves wilt within 24 to 48 hours after bronzing, followed by wilting of the lower leaves within 72 hours. Permanent wilt occurs by the third day, followed by death. The leaves remain firmly attached to the plant. Affected plants die suddenly, often after excellent growth. Trees and shrubs may die more slowly.

Roots are usually extensively invaded by the fungus by the time wilting occurs. Affected plants can be pulled from the soil with little effort. Root bark is decayed and brownish, and bronze colored wooly strands of the fungus are frequently apparent on the root surface.

The fungus generally invades new areas by continual slow growth through the soil from plant to plant. It may also be moved about on roots of infected plants moved to new areas. The fungus can survive in the soil for many years and often is found as deep in the soil as roots penetrate. Affected areas often appear as circular patterns of dead plants. These areas gradually enlarge during the season or in subsequent years as the fungus grows through the soil from plant to plant. Infested areas in cotton may increase 5 to 30 feet per year in cotton.

CAUSAL ORGANISM - Phymatotrichum omnivorum exists in the soil in three distinct forms: (1) hyphae and strands (rhizomorph), (2) sclerotia, and (3) sporemats and conidia.

Hyphae and strands. The fungus produces root-like (rhizomorph) strands that grow through the soil until coming in contact with growing plant roots. Strands grow on roots toward the soil surface. Immediately below the soil surface in cotton, the fungus proliferates around the hypocotyl, producing a cottony, mycelial growth. The bark is destroyed by this mycelium and the fungus fills the vascular tissue of the plant. Sclerotia form in the strands following death of the plant.

Sclerotia. Sclerotia form from strands and the cells divide, grow, and enlarge. These sclerotia are small (1/32 to 1/16 inch in diameter), densely compact masses of thick walled cells. Sclerotia are first white, changing to buff, brown and black with age. They are irregular in shape, generally taking the shape of the pore space where they are formed.

Sclerotia enable the fungus to persist in fallow soil or soil planted to resistant crops for several years. Sclerotia have been found up to 12 feet deep in some soils.

Spore mats and conidia. The fungus often forms spore mats on the soil surface during warm, rainy weather. These mats vary in size from 2 to 16 inches in diameter and are white to tan colored. They are composed of large celled, branched fungal strands that later produce conidia. The conidia are apparently sterile.

CONTROL - Cotton root rot is one of the most difficult plant diseases to control. Fungal behavior in different crops, soils and from year to year in the same field are so erratic that several approaches should be used.

Landscape - A list of ornamental plants with some resistance to cotton root rot is found in Bulletin L-2056.

Rotation. Research shows that rotations of 3 or 4 years with a monocotyledonous crop have reduced disease incidence up to 60 percent on cotton in some instances. Shorter rotations are less effective.

Organic amendments. Significant control of cotton root rot has been achieved by using residues of various crops. A delay in infection of cotton is readily apparent and has resulted in up to 90 percent reduction in root rot. Wheat, oats, and other cereal crops are effective in delaying infection and reducing losses when incorporated in soil in the spring before cotton is planted.

Deep plowing. Use of a moldboard plow to flat break infested areas 6 to 10 inches deep has markedly reduced the incidence of disease. Flat breaking immediately after cotton harvest reduces the strands' ability to form sclerotia. The upper 6 inches of soil should thus have a reduced sclerotia level where 90 percent of the roots of a cotton plant are found.

Plant barriers. This technique consists of planting a resistant grass crop such as sorghum around an infected area in a field. These barriers either exclude or limit the spread of disease within the field.

Fertilizer applications. When nitrogen is applied as ammonia in a manner to fumigate as much soil as possible, root rot may be reduced.

Early plant maturity. A successful technique for cotton is to plant early maturing varieties, such as TAMCOT CAMD-E, TAMCOT SP37H and TAMCOT CAB-CS, as early as possible in the season so that the crops reach maturity before the plant is killed by the disease. Disease activity increases from June through August; therefore, complete production as early as possible.

Cotton Root Rot Control Strategy for Cotton

1. Map fields to define areas infested with the fungus.
2. Shred stalks, moldboard plow and flat break infested areas immediately after harvest 6 to 10 inches deep. Base the depth on equipment and horsepower of tractor. Use sufficient speed to insure good inversion of the plow slice.
3. Prepare field and bed land for sorghum after a 2 week delay.

4. Use maximum recommended amount of fertilizer for sorghum or corn production and apply the nitrogen as ammonia. Apply the ammonia to fumigate as much soil as possible below the depth of flat breaking.
5. Plant sorghum or corn next season.
6. After sorghum or small grain harvest, immediately prepare land for cotton using minimum fertilization.
7. Next spring, plant cotton as early as possible using an early maturing variety such as TAMCOT SP37H, CAMD-E OR CAB-CS.
8. Repeat cycle by again mapping infested areas and deep plowing.

Note: To control root rot, use a total program. By significantly controlling the incidence of root rot at the end of the first rotation, almost total control is possible by the second rotation. Continual monitoring and repeating treatments may be necessary from time to time.

PLANTS RESISTANT TO COTTON ROOT ROT

Based on the work of Dr. J. J. Taubenhaus and Dr. W. N. Ezekiel as well as the work by H. E. Smith L-390 Cotton Root Rot. The following plants are listed as showing resistance to the disease.

E = Evergreen D = Deciduous
S = Semi-evergreen R = Resistant
T = Tolerant

TREES (30 FEET OR OVER)

Scientific Name	Common Name	Foliage Type	Resistance
Acacia farnesiana	Huisache	D	R
Carya spp.	Hickory, Pecan	D	R-T
Cedrus atlantica	Atlas Cedar	E	R
Cedrus deodara	Deodara Cedar	E	T
Celtis laevigata	Hackberry, Southern	D	R
Ehretia anacua	Anacua	E	R
Elaeagnus angustifolia	Russian Olive	D	R
Eucalyptus spp.	Eucalyptus	E	R
Gymnocladus dioicus	Kentucky Coffeetree	D	R
Ilex aquifolim	English Holly	E	R
Ilex cassine	Dahoon Holly	E	R
Ilex opaca	American Holly	E	R
Juniperus scopulorum	Rocky Mountain Juniper	E	R
Juniperus virginiana	Eastern Red Cedar	E	R
Juniperus spp.	Most other Junipers	E	T
Maclura pomifera	Osageorange, Bois D'Arc	D	R
Paulownia tomentosa	Royal Paulownia	D	R
Phoenix canariensis	Canaryisland Date Palm	E	R
Phoenix dactylifera	Date Palm	E	R
Phyllostachys bambusoides	Timber Bamboo	D	R

Scientific Name	Common Name	Foliage Type	Resistance
Pinus densiflora	Japanese Red Pine	E	R
Platanus occidentalis	Sycamore	D	R
Prosopis glandulosa	Honey Mesquite	D	R
Quercus virginiana	Live oak	E	R
Sabal texana	Texas Palmetto	E	R
Sophora japonica	Japanese Pagodatree	D	R
Ulmus crassifolia	Cedar Elm	D	R
Washingtonia filifera	Petticoat Palm	E	R
Washingtonia robusta	Mexican Washington Palm	E	R

LARGE SHRUBS OR SMALL TREES -10 TO 25 FEET

Acacia berlandier	Guajillo	D	R
Cordia boissieri	Anachuita or Wild Olive	E	R
Diospyros texana	Texas Persimmon (Mexican P)	S	R
Ilex crenata	Japanese Holly	E	R
Ilex decidua	Possumhaw Holly	D	R
Ilex vomitoria	Yaupon Holly	E	R
Lippia ligustrina	Privet Lippia	S	R
Parkinsonia aculeata	Jerusalem Thorn (Retama)	D	R
Phyllostachys aurea	Golden Bamboo	D	R
Pithecellobium flexicaule	Texas Ebony	S	R
Prunus mexicana	Mexican Plum	D	T
Punica granatum	Pomegranate	D	R
Sophora secundiflora	Texas Mountain Laurel	E	T

MEDIUM, SMALL OR DWARF SHRUBS - UNDER 10 FEET HIGH

Scientific Name	Common Name	Foliage Type	Resistance
Agava americana	Century Plant	E	R
Aloe spp.	Aloe	E	R
Callicarpa Americana	Am. Beautyberry (French Mulberry)	D	R
Choisya ternata	Mexican Orange	E	R
Cortaderia selloana	Pampasgrass	S	R
Dasylirion texanum	Texas sotol	E	R
Elaeagnus pungens	Elaeagnus	E	T
Fortunella spp.	Kumquat	E	R
Fouquieria splendens	Ocotillo	D	R
Hesperaloe parviflora	Red Yucca	E	R
Hypericum calycinum	Goldflower	E	R
Ilex vomitoria nana	Dwarf Yaupon Holly	E	R
Juniperus chinensis pfitzer	Pfitzer Juniper	E	R
Larrea divaricata	Creosote Bush	E	R
Lavandula officinalis	Lavender	E	R
Lonicera morrowi	Morrow Honeysuckle	D	R
Lonicera tatarica	Tatarian Honeysuckle	D	R
Mahonia tirfoliolata	Agarita or Laredo Mahonia	E	R
Malpighia glabra	Barbados Cherry	D	R
Nerium oleander	Oleander	E	R
Philadephus coronarius	Mockorange	D	R
Rosmarinus officinalis	Rosemary	E	R
Salvia greggi	Autumn sage	D	R

Scientific Name	Common Name	Foliage Type	Resistance
Santolina spp.	Santolina	E	R
Symphoricarpos	Indiancurrent Coralberry	D	R
Orbiculatus			
Yucca spp.	Yucca, Soapweed, Beargrass Spanish Bayonet	E	R

RESISTANT HERBACEOUS OR FLOWERING PLANTS

A = Annual   B = Biennial   P = Perennial

Amaranthus hybridus	Amaranth	A
Anemone x hybrida	Anemone, Windflower	P
Asparagus setaceus	Asparagus Fern	P
Aquilegia longissima	Columbine	P
Antirrhinum majus	Snapdragon	P
Begonia (gracillis) semperflorens-cultorum hybrids	Fibrous or Wax Begonia	P used as A
Canna spp.	Canna	P
Clematis drummondii	Clematis	P
Caladium x hortulanum	Caladium	P
Calendula	Pot Marigold, Calendula	A
Centaurea cyanus	Bachelor's Button	A
Coleux x hybridus	Coleus	A
Cyclamen persicum	Florist's Cyclamen	P
Delphinium spp.	Larkspur	A & P
Dianthus barbatus	Sweet William	P
Dianthus caryophyllus	Carnation	P
Eustoma grandiflorum	Texas Bluebell	B
Freesia spp.	Freesia	P

Scientific Name	Common Name	Type
Gladiolus spp.	Gladiolus	P
Hilichrysum bracteatum	Strawflower	P grown as A
Hemerocallis spp.	Daylily	P
Hyacinthus orientalis	Hyacinth	P
Iberis spp.	Candytuft	P
Impatiens balsamina	Garden Balsam	A
Iris spp.	Iris	P
Lilium spp.	Lily	P
Lobularia maritima	Sweet alyssum	P used as A
Lathyrus odoratus	Sweetpea	A
Lupinus subcarnosus	Bluebonnet	A
Mentha spp.	Mints	P
Narcissus spp.	Narcissus and Daffodil	P
Nemophila spp.	Baby Blue Eyes	A
Pelargonium domesticum	Lady Washington Geranium	P used as A
Papaver orientale	Oriental Poppy	P
Petunia bybrida	Petunia	A
Phylox spp.	Phylox	A
Ranunculus macranthus	Showy Buttercup	P
Ranunculus muricatus	Roughseed Buttercup	P
Ranunculus parviflorus	Sticktight Buttercup	P
Ranunculus sceleratus	Blister Buttercup	P
Ranunculus repens	Creeping Buttercup	P
Ranunculus fascicularis	Early Crowfoot	P
Ranunculus pusillus	Lesser Spearwort	P
Salvia azurea	Blue Sage or Salvia	P

Scientific Name	Common Name	Type
Salvia offinalis	Garden Sage or Salvia	P
Salvia greggi	Autumn Sage or Salvia	P
Salvia reflexa	Lanceleaf Sage or Salvia	A
Salvia spendens	Scarlet Salvia	P
Sisyrichium spp.	Blue-eyed Grass	P
Trollius europaeus	Globe-flower	P
Tagetes spp.	Marigold	A
Tropaeolum majus	Nasturtium	A
Tulipa gesneriana	Tulip	P
Viola odorata	English Violet	P
Viola tricolor	Field Pansy or Johnny-Jump-Up	A
Zinnia augustifolia	Mexican Zinnia	A
Zinnia elegans	Common Zinnia	A

CROWN GALL

Crown Gall (bacterium - Agrobacterium tumefaciens): Crown gall first appears as small round overgrowths on stems and roots. As they enlarge, the galls become woody with a rough and irregular surface. Aerial galls can develop but most are found at or just below the soil line. Galls range from pea-size to larger than 1 foot in diameter.

Crown gall is worldwide in occurrence, attacking 140 plant genera in 60 different families. Plants most commonly damaged in Texas by crown gall are pecan, peach, blackberry, grape, apple, pear, willow, pyracantha, euonymus, rose, fig, and crabapple.

Crown gall bacteria infect plants through wounds, such as those arising from cultivation, transplanting, wind damage, insect injury, etc. Wounds that have healed beyond a certain point are no longer susceptible to invasion. After establishing itself in the wound, the bacterium transforms normal plant cells to tumor cells. Once this has taken place, the tumor cells are able to reproduce without the bacterium being present. Although crown gall of plants is very much like cancers in humans and other animals, there is no relationship between crown gall and animal cancers. Crown gall has been studied extensively by scientists in their search to understand cancerous growths.

Damage to infected plants results from interruption of water and nutrient movement up the stem. Galls also interfere with normal growth and development, therefore, infected plants may be stunted and unthrifty. With many plants, the amount of damage depends on where the gall or galls are located and how many are present. Death can result if galls girdle the primary trunk or stem. Infected plants are more sensitive to winter injury and drought stress. Control is primarily dependent on prevention. Pruning off galls is not effective since the bacterium is systemic and gall tissue can reproduce itself. Chemical control with antibiotic drenches has shown promise; however, they are not practical at this time. The following practices pertain to homeowners and/or nurserymen.

(1) Inspect plants for crown gall before purchasing. Plant only crown gall-free trees and shrubs.
(2) Remove and destroy heavily infected and weakened plants. Dig up as many roots as possible.
(3) Replace with a more resistant type plant if possible.
(4) Avoid wounding plants while mowing, cultivating, etc.
(5) Keep plants in an active growing state with proper fertility and watering.
(6) Heavily infected nursery fields should be planted to a grass crop for three years before planting susceptible nursery stock.
(7) Control root feeding insects.
(8) Dip grafting and pruning tools regularly in a disinfecting solution, such as 70 percent alcohol, 10 percent sodium hypochlorite (common bleach) or potassium permanganate solution (1 ounce in 2 gallons of water).

CURLY TOP

Virus strains responsible for curly top infections in Texas are notable for: (a) their wide distribution, (b) ability to attack numerous vegetables, field, and forage crops, as well as a great many ornamental plants and weeds, and (c) their destructiveness which may range from disguised effects invisible in the field to total destruction of the affected plants.

Symptoms: External symptoms of curly top virus infection may appear in leaves, stems, flowers, fruits, or roots of infected plants. Generally, mottling is absent, but infected plant parts may become distorted through curling, twisting, rolling, stunting, etc. Leaves become thickened and leathery. Both yield and quality of the product of an infected plant may be impaired by curly top virus. Fruits frequently ripen prematurely, have an odd taste and reduced sugar content. This is especially true in tomatoes, melons, and other cucurbits. Some of the most pronounced symptoms resulting from curly top virus attacks are internal and non-observable with the unaided eye. Such internal symptoms consist of death of the food conducting vessels, as well as of extreme variations from the normal in numbers and sizes of cells composing the plant tissues involved.

Transmission: Curly top virus is transmitted only by the sugarbeet leafhopper. (*Circulifer tennelus*). No strain of curly top virus is easily transmitted by other methods. True seed transmission does not occur, although in potatoes the persistence of the virus in seedpieces from infected tubers has been reported.

Control: Losses can be reduced in many instances by: (a) use of resistant varieties of plants, (b) sanitary measures including the eradication of susceptible weeds and susceptible volunteer crop plants from a previous planting, (c) regulating the time of planting in order to avoid the main flights of the sugarbeet leafhopper, (d) use of barriers of trap crops and mechanical barriers of fine mesh materials, (e) insecticides, (f) shading small plantings to discourage leafhopper invasion, (g) thicker planting and (h) early roguing of infecting plants.

DODDER

Parasitic Plant (plant -- *Cuscuta* species): Dodder is also known as strangle weed, pull-down, hellbind, devil's hair, love vine and hailweed. It is a parasitic plant that grows from a seed. The seeds germinate in the spring and send up long, twining thread-like stems. The vine attaches to susceptible plants and twines around the stems and petioles. By the time dodder becomes noticeable, the thread-like stems are yellow to orange in color. There are no leaves on the slender, twiney stems.

Host plants are weakened, stunted, and may fall over. Field infestations start as circular areas and continue to enlarge during the growing season. Yields of legume crops, such as alfalfa, lepedeza or yuchi clover, can be greatly reduced. The greatest loss occurs in legumes grown for seed. Seed cleaning may also be a major cost. Only certain levels of dodder seed are tolerated in crop seed sold in Texas. Southern greens infected with dodder are not acceptable to processors. Onion yields can be reduced. Thickets of live oak sprouts and other woody plants are attacked by some dodder species. Small grains, corn sorghum, and other grass crops are not hosts of dodder.

Control is best achieved by preventing introduction of dodder into fields either with planting seed or by infected plant material. Equipment should be cleaned before moving it from dodder-infested fields. When an infestation is present, spot treat with a herbicide that will kill the host or use a weed burner. Certain herbicides (Dacthal for example) that prevent germination or kill in the seedling stage can be used when entire fields are infested. Homeowners with contaminated flower beds should handpick the dodder and destroy it before seeds are formed.

See USDA Farmers' Bulletin No. 2276.

DROUGHT SYMPTOMS ON PLANTS

The most common symptom of drought injury is dying around margins of leaves with the dead leaf tissue between veins toward the midrib. Areas 1/4 to 1/2 inch wide along veins are the last to become desiccated.

Drought injury can occur naturally or it may be induced by man. Natural drought injury occurs when there is an inadequate supply of soil moisture available to the plant. A deficiency of water affects the marginal leaf tissue more than other parts of the plant which results in a partial or complete collapse of the cells. Prolongation of this state results in the death of feeder roots and, therefore, recovery of the plant to the normal condition is slow.

Man-made drought injury occurs when roots have been damaged mechanically or when there is an excessive accumulation of salt in the soil. Salt accumulation can develop by using irrigation water containing salts or by the use of excessive rates of inorganic fertilizers. High salt concentrations in the soil solution reduces water absorption by root hairs. In time, the osmotic pressure (pull) in the soil becomes greater than that in the cells of the roots and under such conditions the net movement of water is from the roots into the soil. This can occur even though there is abundant moisture in the soil. This phenomenon is frequently referred to as "reverse osmosis."

Root pruning will also cause drought symptoms to occur. Cuts or fills made while installing curbs or other masonry structures may cause root pruning. The construction of driveways, patios, and other masonry or asphalt structures near or around trees will interfere with the exchange of gases around the root system and result in root pruning. Excessive amounts of fill soil around a tree or other plants causes this same type of root pruning due to poor aeration. When it becomes necessary to build patios or driveways near shade trees, care should be taken to prevent mechanical root pruning and also provisions should be taken to incorporate a tile system in the structure to permit proper aeration.

MUSHROOM ROOT ROT

(Oak Root Rot)

Mushroom Root Rot (Oak Root Rot) (fungi - *Armillaria tabescens*, *Ganoderma lucidum* or *Armillaria mellea*): Mushroom root rot attacks a wide range of orchard and shade trees as well as shrubs. First symptoms range from a slow, gradual decline to rapid death. Slow death of the tree or shrub after the affects of infection are noticed in the aboveground parts is the most common.

Dead areas are produced in the bark on the main stem and larger roots just beneath the soil surface. When the dead bark is peeled back, the white growth of the fungus over the surface of the wood constitutes a distinguishing character of this disease. The fungus occurs most frequently in woody areas or in recently cleared land. All stumps and large roots should be removed as thoroughly as possible before orchard or valuable trees are set in infested land. Planting of newly cleared land to an annual crop for several years helps to reduce this fungus.

Since the pathogen exists in most forested soils, mushroom root rot is usually related to previous stress in the tree which lowers host vigor. The stress may be environmental such as drought, flood or poor drainage; people-caused, such as construction, fill, or chemical injury; or biotic, such as severe or repeated defoliation by insects or diseases. Helping the tree to avoid stress is therefore an important part of prevention.

Lawngrass sod growing too close to a tree or shrub may encourage attack by the oak fungus. Chinaberry, rose, pyracantha, elagnus, arborvitae, and cultivated junipers have appeared especially susceptible to this disease. Peach and plum orchards are also frequently destroyed. Native yaupon and cedar are resistant. Photinia, gardenia, wax-leaf ligustrum, Japanese privet and crapemyrtle have been known to escape the disease in infected areas. Soil fumigation has not proven effective. The fungus can survive on small dead roots. Therefore, remove from the soil as many roots as possible before replanting. In addition, soil around the old root system should be fumigated or replaced with fresh soil. The objectives of these treatments are to reduce the amount of the fungus in the soil and to remove any substance that the fungus can live on.

MYCOTOXINS

Mycotoxins are chemical compounds produced by fungi growing on organic substances such as corn, cottonseed or peanuts which, when consumed, have some undesirable effect on the animal consuming them. These effects can range from vomiting, feed refusal, weight loss, various types of tumors, and in some cases death. More than 100 toxic compounds produced by fungi have been identified and about 45 of these occur in grain crops. Some mycotoxins are rather rare in occurrence; others such as aflatoxin are quite common in some years.

Mycotoxins have probably been present in man's food supply since the beginning of civilization. However, increased use of mechanical harvesting may have resulted in increased harvest of badly molded grains that would have been discarded with hand harvesting.

The seriousness of the mycotoxin problem varies with the year, the crop being grown and the intended use of the crop product. The producer of agricultural commodities stands to lose most from contamination of his product. For this reason, producers should be constantly aware of the possibility of mycotoxin contamination.

Aflatoxin

Aflatoxins are a type of mycotoxin produced by the *Aspergillus flavus* group of fungi. *Aspergillus flavus* is a common fungus and can be found in soil, air, and decaying plant residues. Infection by *A. flavus* and subsequent aflatoxin production can occur in the field, in transit and in storage. Most reports indicate that infection occurs in the field while aflatoxin production can occur whenever the product is exposed to favorable conditions either in the field or in storage.

Conditions favoring the aflatoxin-producing fungus, *A. flavus* are as follows:

Factor	Optimum	Range
Temperature	86°F plus	80 to 200°F
Relative humidity	85 percent plus	62 to 99 percent
Kernel moisture	18 percent	13 to 20 percent

The figures listed above were taken from several sources and in some cases represent compromises among findings. In many cases, development of the fungus usually stops when the temperature is below 55°F and grain moisture is 12 percent or below.

Drought is considered to be one of the major factors that predisposes corn and peanuts to infection by *A. flavus*. In 1977, drought stressed corn in the southeastern states was plagued with a high incidence of aflatoxin. In 1980, aflatoxin was reported in higher than normal levels in the Southeast as well as Texas, Missouri and even southern Illinois. Corn is especially subject to aflatoxin problems when drought occurs.

Management Practices to Minimize Aflatoxin at Corn Planting and During the Season

1. Select a regionally adapted variety.
2. Use a balanced fertilization program designed for optimum yields.
3. Select a planting date that has traditionally resulted in the highest yield on your farm or in your area.
4. Follow normal cultural controls to limit damage by ear feeding insects including early planting dates.
5. Attempt to best utilize your irrigation practices to deliver optimum water from silking stage to late dough stage.

Harvesting

1. Make adjustments in combine ground speed and cylinder speed to minimize trash and broken kernels from ending up in the hopper. Aflatoxin is often associated with broken or light weight kernels.
2. If drought has occurred during the season, consider harvesting irrigated or high yielding fields separately from dryland or poor yielding fields. This will allow some loads to escape from being contaminated with high numbers of infected kernels.
3. Aflatoxin can increase in corn standing in the field if the moisture content is above 18 percent. If corn has dried below 15 percent, do not allow late season rains to raise the moisture content back up to levels where more aflatoxin can be synthesized by the fungus growth already in kernels. Harvest corn when hurricanes or late season fronts threaten.

Handling

1. Improper handling of high moisture grain can lead to continued _A. flavus_ growth and aflatoxin production before storage. Do not hold high moisture corn in wagons or similar holding areas for more than 6 hours. Place high moisture corn awaiting drying in a "holding bin" or "wet bin" and force air through it to keep it cool.
2. Corn which collects in auger wells and pits around dump stations frequently contains the fungus _A. flavus_. Thoroughly clean all such areas before and after use. Remove leftover grain from trucks, trailers, holding bins, drying facilities and storage bins before beginning a new lot of grain.

Storage

Moisture content is by far the most important factor affecting the growth of microorganisms in stored grains. The long-term safe storage moisture content for corn in Texas is 13 percent. After harvest, cool grain as soon as possible and dry down to 15 percent. Do not dry corn too fast as rapid drying may cause cracking and unacceptable quality losses.

Methods of Detecting Aflatoxin in Corn

Blacklight: Corn contaminated with kernels infected with _Aspergillus flavus_ will often produce a characteristic bright greenish-yellow flourescence (BGYF) when examined in a darkened room under long wave ultraviolet light or what is commonly called a blacklight. This fluorescence is the result of the properties of Kojic acid. Kojic acid is another compound produced by A. flavus; it is not related directly to aflatoxin. The blacklight test is a presumptive test and assumes aflatoxin is present if the presence of Kojic acid indicates that A. flavus is present. Blacklight positive samples usually contain some aflatoxin but this method cannot determine if the load exceeds the F.D.A. Guideline of 20 ppb. If a load of corn is found to be positive with a blacklight test, it is recommended that a representative sample of this lot be taken and a determinative test such as a minicolumn or other test be performed.

Minicolumn Test or Holiday Minicolumn Test: The minicolumn test is a determinative test for aflatoxins. It is rapid, relatively inexpensive and can be performed at the buying point. This test is commonly employed to determine if corn exceeds the FDA Guideline of 20 ppb. If the sample used for analysis is representative of the entire load, it is an acceptable method for determining whether to accept or reject loads.

Thin-Layer Chromatography (TLC): The thin layer chromatography method for determining aflatoxin is a more precise measure of determining aflatoxin concentrations in corn. If this method is coupled with AOAC (Association of Official Analytical Chemists) approved extraction methods, it is superior to other methods of quantitating aflatoxins. This method is commonly employed by testing laboratories.

Rapid Test Kits: Recently, several commercial firms have marketed rapid test kits for use in determining the aflatoxin concentration in corn samples. These test kits are self contained and provide all the necessary instructions to complete an analyses on-farm, at the elevator, or at the buying point. Several kits are available at varying prices (ranging from $5-15/test depending on quantity ordered). The following table includes sources for 3 such test kits.

Product Name	Company	Price/Test (1987)	Approximate Assay Time
Aflatest 10	Cambridge-Naremco P.O. Box 1572SSS Springfield, MO 65805 (1-800) 641-7515	$195/25	20-30 minutes
EZ-Screen Quick-Card	Environmental Diagnostics, Inc. 2990 Anthony Rd. Burlington, N.C. 27215 (1-800) 334-1116	$75/10	30 minutes
Agri-Screen	Neogen Corp. 620 Lesher Pl. Lansing, MI 48912 (517) 372-9200	$77/12	30-40 minutes

Other methods of determining and quantifying aflatoxins are available. As research discovers new techniques, they will likely be employed. It is important, however, to remember that aflatoxins are concentrated in a few kernels that contaminate an entire load. For this reason, a representative sample is essential to determine the degree of contamination. A multi-level probe sampling at several sites and depths will give the best results. AOAC approved methods generally agree that an initial sample weight of 10 pounds (5 kilograms) is desired.

Reducing Aflatoxin in Contaminated Corn

Detoxification: Several compounds are under investigation for detoxification of aflatoxins from corn. One such method being examined in southeastern states is use of anhydrous ammonia. This method has shown some promise in feed corn, but problems with feed refusal have limited its use. Also, kernel discoloration results from this method, and this has prohibited its use in food grain corn.

Blending: The physical mixing of contaminated (greater than 20 ppb) corn with uncontaminated (less than 20 ppb) corn is not a recommended practice. While occasionally successful, too often the result is a larger lot of contaminated corn. Efforts to separate and work with contaminated lots through screening or alternative usage will give the most consistent and desirable results in marketing contaminated corn.

Screening: The use of small opening screens has resulted in successfully reducing the aflatoxin concentration in food grade or other high value corn. Screening removes broken kernels which often contain a high percentage of the aflatoxin contamination. Screening has been coupled with the use of vibrator or gravity tables which remove any light-weight, infected kernels and thus further reduce the aflatoxin concentration in food grade corn. Screening corn can significantly reduce the aflatoxin concentration in corn with only a minimal (5 to 10 percent) loss in grain weight or yield.

Management Practices to Minimize Aflatoxin in Peanuts

Planting and During the Season

1. *A. flavus* is common soil fungus and may increase in population on certain crop residues including peanuts. Fungal populations increase on certain soils where peanuts follow peanuts. Using crops other than peanuts or corn on these problem fields helps reduce the population of the fungus in the soil.
2. Peanut or corn residue on the soil surface favor the increase of the organism. Deep burial of crop residue is recommended.
3. Control pod damaging insects such as lesser cornstalk borer. Damage by this insect may increase incidence and detection of this problem.
4. In problem fields where peanuts follow peanuts, a late planting may be advisable. When peanuts mature during the cooler temperatures at the end of the growing season, it lessens the degree of Segregation III occurrence.

Harvesting Procedures

1. Use an inverter digger to keep pods off the soil surface while curing within the windrow. Do not place more than two rows together in a windrow unless vines are very small. This increases ventilation around the pods and facilitates rapid and uniform drying. Leave peanuts in the windrow only long enough to achieve the desired combining moisture of 18 to 25 percent. Increased length of exposure heightens the chance of exposing dry peanuts to late season rains.
2. Some mold damage and aflatoxin accumulation develop during harvesting and curing. Adjust combines to prevent pod damage and transport peanuts in vented trucks and trailers to prevent heating. Force air through the truck or trailer.
3. Dry peanuts immediately following harvesting without undue delays in transportation equipment.
4. Do not blend or mix damaged or lower quaity peanuts with high quality ones in the same truck or trailer. Harvest good fields or good portions of a field into separate trucks or trailers. Remember that it only takes one kernel to condemn an entire load.

Methods for Detecting Aflatoxin in Peanuts

The visual method for detecting aflatoxin in peanuts is a presumptive test based on the observance of visible growth of Aspergillus flavus on a sample drawn from a peanut load. Any lot of farmer's stock peanuts which contain any visible A. flavus mold on any kernels or portion of kernels will be classified as Segregation III regardless of the percentage of damage. These peanuts must be diverted to oil stock where the use of meal is restricted to non-feed uses. This determination should be made with the aid of a low power microscope. This procedure is indirect and does not give an indication of the actual quantity of aflatoxins present.

NEMATODES OTHER THAN ROOT KNOT

Nematodes other than root knot which commonly cause plant injury are Helicotylenchus spp., Hoplolaimus spp., Heterodera spp., Globodera spp., Tylenchorhynchus spp., Xiphenema spp., Trichodorus spp., Longidorus spp., Belonolaimus spp., Rotylenchulus spp., Paratylenchus spp., Punctodera sp., and Paratrichodorus spp. Except for Heterodera spp. and Rotylenchulus spp., most are of the migratory type. That is, they are mobile in the soil and move from feeding site to feeding site on the host plant. When crops show slow decline, unthriftiness, chlorosis or slower than normal growth, nematodes other than root knot may be the cause. During periods of stress, infested plants will tend to wilt first. Other symptoms include a crooked or brushy appearance of fleshy tap roots, stubby, small root systems with excessive branching; small roots larger near the tip; brownish to black spots or streaks on roots. In many instances, nematodes occur as part of a fungal or bacterial disease complex. Plants attacked by nematodes are more susceptible to other unfavorable environmental conditions such as drouth injury, winter injury or excessive moisture.

Plant parasitic nematodes are microscopic in size which explains why they are often overlooked as causal agents. In addition, the above ground symptoms are typical of a large number of infectious and non-infectious root diseases. Nematodes live on the thin film of water that surrounds each soil particle and are, thus, very sensitive to dry soil conditions. Nematodes move very slowly in the soil but are moved in running water or contaminated equipment. If nematodes are suspected in an area, submit a soil sample to the Texas Plant Disease Diagnostic Laboratory. Control methods are the same as for root knot.

Root Knot (nematode - Meloidogyne spp.): Root knot disease occurs in nearly all parts of the state and on most plant species. Certain species are specific to individual plant hosts. Above ground symptoms are similar to many other root diseases or environmental factors limiting water and nutrient uptake. These symptoms consist of wilting during periods of moisture stress, stunted plants, chlorotic or pale green leaves, and reduced yields. Most characteristic symptoms; however, are those occurring on underground plant parts. Infected roots swell at the point of infection and form knots or galls. Several infections may occur along the same area resulting in large fleshy galls. The appearance of galls will depend in part upon the host and the nematode species involved. Generally, fast growing annuals will have a large flesh gall and woody perennials, small hard galls. Infected roots are retarded in growth and lack fine feeder roots. Rotting of roots may develop late in the season. When tubers, corms or other edible root portions are infected, small swellings or pimpling is evident on the surface.

The Pathogen (Meloidogyne spp.): Although different species of root knot nematodes vary in their host-parasite relationships, all have basically the same life cycle. The infectious stage of this nematode is the second stage larvae which occurs free in the soil (The larvae has already molted once in the egg). The second stage larvae will penetrate the plant at or near the root tip and become sedentary. An enzyme is released which causes the plant cells surrounding the head region to enlarge, forming giant cells which serve as a source of nourishment for the parasite. The female nematodes swell until they become pear-shaped or oval. During this time, the nematode undergoes two more molts. Females begin laying eggs around 20 days after penetration of the host. The average female will lay approximately 30 eggs a day for two weeks. The average life cycle is 25 days. Populations will build up rapidly when environmental conditions are favorable.

Control: (1) Crop Rotation - a three or four year rotation program with resistant crops is an effective program. Most of the cereal crops are fairly resistant.

(2) Resistant or Tolerant Varieties - Some vegetable and field crop varieties have resistance to root knot nematodes, and are advertised as such. Reaction of several ornamental plants is given in a table at the end of the Shrubs section on root knot disease.

(3) Clean Summer Fallow - dry summer fallow with cultivations every 3 to 4 weeks is an effective method of reducing nematode populations. This method may be impractical in some instances.

(4) Selection of Planting Stock and Planting Sites - Select transplants free of root knots. Plant roots should be washed and carefully inspected for signs of nematode injury. Select planting sites free of nematode infestations. An indicator crop of tomatoes, okra or other susceptible plants could be grown in the area if you do not know rotation histories. Submit soil samples to the Plant Nematode Detection Laboratory for analysis.

Chemical Control - Nematicides are effective, well accepted and can give good economic returns on high value crops. Treatment is sufficient for a year and retreatment usually will be required the following year if susceptible plants are to be grown. Application methods are dependent upon the type of material used, along with conditions in the area requiring treatment. Most nematicides are either injected into the soil or washed in by a water drench. Nematicides may be purchased in liquid or granular forms, with application directions dependent upon the type of plants growing or to be grown. When possible, nematode-infested soil should be treated before planting seed or setting transplants.

Nematicide Application Methods: (1) Preplant-application - First decide whether row or broadcast treatment is desired. If plants are to be cultivated in a row, treat only the potential root zone. Soil should be tilled deeply to prepare a good seedbed. Cover immediately to prevent material loss. For best results, soil moisture conditions should be just right for cultivation or planting and the soil temperature should be between 60 and 80°F. Nematicides diffuse approximately 6 inches from point of application to give a treatment zone 12 inches wide and 12 inches deep. Applying materials on 12-inch centers results in overall or broadcast soil treatment.

(2) Side dressing nematode-infested plants - Make sure the material on hand can be used around living plants without causing injury. Dig a trench to the side of the pants as directed on the label. Cover the material immediately and water to cause diffusion of the material into the root zone. Make sure all label precautions are followed as they relate to chemical rate and plant growth stage.

(3) Drench for established shrubs and trees - Infested shrubs and trees may be treated by building a dike around the tree base that will contain water-diluted materials until they penetrate the root zone. The dike should be large enough in diameter to accommodate a majority of the feeder roots. The nematicide should be accurately measured and diluted in sufficient water to penetrate the root zone. After material penetration, add water to wash the nematicide down into the root zone.

(4) Treatment of established turf - After application of Granular materials, water to leach the material into the root zone.

PLANTS THAT GROW ON OTHER PLANTS

(Parasitic and Epiphytic Plants)

Ball Moss (plant - *Tillandsia recurvata*): Ball moss has caused concern among homeowners in the southwest part of Texas for many years. Ball moss is an epiphyte. It grows on the bark of a number of Texas shade trees; live oak, post oak, hackberry, tallow, cedar, and others. It first occurs as small, gray green tufts that develop within a relatively short time into a dense "ball" composed of numerous individual plants. The plants form root-like holdfasts which penetrate into the rough bark of the tree. These holdfasts often completely encircle a limb. Spread is by windblown seeds which are produced on 3 to 4 inch long stalks. The seed are light and are covered with a fluffy material which aids in their movement. Within the last few years, the plant has been spreading eastward from its former Southwest Texas habitat.

The use of the fungicide Kocide 101 at the rate of 4-6 pounds/100 gallons of water will control the plant. Applications should be made in the spring (late February, March or April) just prior to the normal spring rainy season. Kocide applied during dry periods will not be as effective. When ball moss growth is dense, an additional application should be made 12 months later. Generally, no more than two applications are required for control of ball moss depending upon how large an area is sprayed and how many trees are in the area that can serve as a seed source.

Spanish Moss (plant - *Tillandsia usneoides*): This long, whisker-like plant growth hangs from trees in Southeast and East Texas. It is an epiphyte. It grows on hardwoods and conifers along rivers and creeks in the more humid areas of Texas. It is a member of the pineapple family (Bromeliaceae). It has been reported to kill trees where development is extensive. This seldom occurs. It can be removed using mechanical means where growth becomes thick enough to cause tree damage. Chemical treatments are not recommended.

Mistletoe (parasitic plants - *Phorandendron flavescens* var. *villosum*, *P. flavescens* var. *pubescens*, *P. flavescens* var. *macrophyllum*, *P. bulleanum* var. *bolleanum*, *P. bolleanum* var. *capitellatum*, *P. juniperinum*): Mistletoes are parasitic plants which derive their food from the host plant. In severe cases mistletoe will kill trees. The seeds of mistletoe are borne as white fruit on female plants. These berries are sticky and are spread by birds. The seed germinate and penetrate young, thin bark. As the seed germinate, a haustorium is formed which penetrates the cambium and eventually on into the wood. Infection often causes large swellings to be formed around the point of entry.

Chemical control has not proven satisfactory, even though a large number of chemicals have been evaluated. Physical removal has been used but is only successful if the haustoria are removed. This may mean removing a large portion of the limbs in some trees. Cuts should be made 12 to 18 inches below the area where the mistletoe is attached. A hoe or rake have sometimes been used to brush the plants off the trees, but this gives only short term relief with new growth springing up from the point of attachment.

Lichens: A lichen is a combination of a fungus and a green or blue-green alga enclosed by the fungal hyphae. The fungus obtains food from the alga, which manufactures food through photosynthesis and the alga receives some of its food and protection from the fungus. Three forms of lichens exist - crustose (flat type of growth), foliose (leaf-like but with prostrate growth), and fruticose (bush-like and erect or hanging growth). The effect of lichens on trees is only slightly damaging. Heavy lichen growth indicates poor tree growth as a result of some other cultural problem. Lichens can restrict gas exchange from the limb or twig and can restrict the amount of light received by a limb.

Materials used in the control of ball moss will kill the lichens for a short period. Regrowth usually occurs within the same year after the tree was sprayed. Chemical control of lichens is not currently recommended. This is due to two reasons, one, chemicals are currently not cleared by EPA and control has not been of ong enough duration to warrant spraying. Rather, trees should be encouraged to develop a dense canopy which will shade out the lichen growth.

SEEDLING BLIGHT
(DAMPING OFF)

Cause: A large number of soil-borne fungi, bacteria and nematodes are present within the upper few inches of soil. A majority of these under specific environmental conditions can cause plant disease. As we consider the soil-borne organisms that cause seedling diseases, we must remember that some of these microorganisms are beneficial for plant growth.

All plants have associated with their root systems certain groups of microorganisms. These organisms are activated by the presence of the plant roots and the substances released by them. Some remain active within the zone of the root influence while others are more active on the root surface. Others invade the root directly or through wounds and move into the cortical tissues or on into the vascular system. Obviously, the microorganisms obtain their nutrients from the plant. Some microorganisms release various substances (enzymes) which the plant may absorb and which may disrupt normal plant growth processes.

Symptoms: Diseases of the damping-off type occur during the early stages of plant growth especially when soils are cold. Immature seedlings are more susceptible than older plants. Three stages of growth during the susceptible stage have been described. First, the germinating seed becomes susceptible once it begins to swell and breaks, allowing potential damping-off organisms to gain entrance. Second, the new roots or shoots which emerge from the seed before it emerges from the soil may be attacked. Third, young seedlings may be damaged at or near the soil surface following emergence, causing them to fall over.

Control: Overwatering tends to encourage damping-off; only enough water should be added to seedlings to prevent wilting. Water in the morning and allow to dry before night. When seedlings begin to damp-off, they should be given as much light as possible. Sterilization of the soil before planting is one of the most satisfactory means of preventing loss of seedlings in garden areas. Small lots of soil can be baked for 3 to 4 hours in a 160°F oven to kill the damping-off organisms.

Damping-off can also be controlled to a marked degree by seed treatments and soil drenches. Use fungicides at rates recommended on the label. Fungicides considered as good soil drenches include Captan, Thiram, Terraclor, and Benlate.

In many cases, seed treatment alone is sufficient to protect the young plants against damping-off disease.

SOOTY MOLD

Sooty Mold (fungi - Capnodium spp., Fumago spp., and others): Sooty mold is a name commonly given to a condition that is not truly a disease, but a black coating on leaves, branches and fruit made up of fungal growth. The fungus is usually dark colored and powdery-like, hence the name sooty mold. The fungi associated with this condition are saprophytic, that is, they do not feed on live plant tissue, but rather thrive on insect secretions with a high content of sugars. These secretions, known as honeydew, are particularly common with aphids, scales, white flies, and other insects. The insect honeydew provides nourishment for the fungus, and under proper conditions, the entire plant may be covered with the sooty mold.

A black velvety coating made up of the fungal strands is formed on the surface of leaves, twigs and fruit. If the honeydew is light, it may appear only in spots. As a general rule, the black fungus coating usually can be rubbed off easily from the surface of leaves, fruit or branches. With time, the fungus may dry-off, become flaky, and fall off. If for some reason the insect infestation decreases, the amount of sooty mold also will decrease. If no insects are present to cause a re-infestation, rains will usually wash off most of the sooty mold.

The fungi causing sooty mold are known to occur on citrus, oleander, gardenia, fig, crapemyrtle, azaleas, pittosporum and many other ornamental bushes and trees. Control can be obtained by applying insecticides that reduce insect populations. Using oil formulations as insecticides is effective, since oil gets rid of many of the insect pests and also softens the black fungus so it can be washed off easier by rain or other means.

SOUTHERN BLIGHT

Cause: A soil-borne fungus - Sclerotium rolfsii.

Symptoms: Whitish fungal growth develops around the base of herbacious plants (and a few woody plants) at the ground line. Small seed-like structures (sclerotia) are found with the fungal growth. They are white at first and later turn dark brown to black. Plants wilt and die suddenly after the fungus girdles the stem.

Disease development: Southern blight is especially destructive on crops such as tomato, beans, peas and peanuts. Many other plants including annual ornamentals are also susceptible. The fungus develops rapidly during hot weather when temperatures are over 85°F. It grows on living and non-living organic matter and becomes most severe when dead leaves or other types of organic matter are present around the base of the plant. This permits the fungus to build up momentum by utilizing energy from the decaying organic matter and rapidly kill the host plant. The fungus develop rapidly when summer rains occur after a drought. This stimulates germination of the sclerotia (seed-like structures) and furnishes needed moisture for fungal growth. If the fungus finds ample organic matter and host plants, a large supply of sclerotia are produced for next year. These structures have a hard thick covering that resists weathering.

Control: Southern blight can be controlled with cultural and chemical techniques. Burying crop residue deep enough to prevent its being brought back up with land preparation and cultivation practices will remove the fungus and its food source. The fungus requires oxygen for development and deep burial reduces its activity. Keeping fallen leaves or other organic matter from the base of the plant is helpful. Using foliage fungicides to prevent foliage diseases will help keep leaves on the plant and off the ground. Fungicides may also be applied to the soil on certain crops. This will inhibit development of the fungus. Planting on a slightly raised bed help reduce damage on some crops.

STEM AND ROOT ROT

Cause: Species of soil-inhabiting fungi such *Rhizoctonia*, *Fusarium* and *Pythium*.

In many cases, the disease is a continuation of seedling blight. Spots of various sizes occur on the stem, at or near the soil level and on the roots. These spots may vary in color from gray, brown, black, or even bright red. Frequently, these fungi cause the tips of fibrous roots to decay. Wilting, dieback, and poor vigor are common symptoms. Plants are often predisposed to infection by poorly drained soils, crowding, mechanical injury, over-watering, improper balance of plant nutrients or other factors that affect plant growth. Containerized plants often suffer root rot even though factors other than fungi may be the primary cause. Roots on potted plants can be checked for vigor by carefully removing the pot when the container is inverted and the plant is supported at the base with one hand. Dark decaying roots on the outside of the soil mass indicate a root rot condition may exist.

Control is difficult because once symptoms are observed, damage to the stem or roots is usually severe. For small flowerbeds and potted plants, use a soil drench of a recommended fungicide. A fungicide could also be mixed with soil prior to planting as suggested by the manufacturer. Allow excessively wet soils to dry. Always avoid throwing soil to stems when cultivating and avoid crowding plants in seedbeds or other areas. When transplanting or repotting, place plants at the same soil depth. Do not mulch heavily with partially decomposed organic matter. In the field, cover crops should be plowed under early to allow complete decomposition before a susceptible crop is planted.

Nematodes may cause symptoms similar to stem and root rots. See sections on Nematodes other than Root Knot, Southern Blight, Seedling Blight, Mushroom Root Rot, and Cotton Root Rot. All of these can cause stem and root rot type symptoms.

VIRUS DISEASES

Viruses are sub-microscopic infectious particles that multiply only inside living host cells. Viruses are for the most part beyond the resolution capabilities of a light microscope. Consequently, virus structures have been determined primarily by electron microscopy and X-ray defraction. The plant virus shapes are rigid rods, flexous rods and polyhedrons. They vary in size from about 20 millimicrons to 1200 millimicrons. Plant viruses are made up of two components - a protein coat and the nucleic acid center. The nucleic acid is the infectious component of a virus. Viruses are obligate parasites, meaning that they must be within living tissue before they can reproduce themselves. The require a wound to gain entrance to a plant cell. In nature, they depend primarily on biological agents such as nematodes, insects and man for their dissemination. Once duplication starts, the virus is translocated from cell to cell through the plasmodesmata and to distant plant parts by the phloem.

In general, viruses are seldom lethal to plants, but do severely affect the host both in quantity, quality and longevity. Symptoms may often be very characteristic for a specific virus on a specific host. Symptoms along with other criteria are used to identify virus diseases. An advanced array of symptoms can be recognized today as expressions of viral diseases in plants. Some of these would include abnormal leaf color, abnormal vein patterns of leaves, mottling in leaves, spotting patterns in leaves, and abnormal leaf shape. There are also abnormalities of flower color, and fruit size, shape and color. With some virus diseases, the symptoms are masked.

Viruses can be spread from plant to plant by several means. Some of these would include transmission from the parent plant to an offspring through the genetic structure of the plants. Other ways in which viruses can be transmitted are through vegetative propagation, grafting and budding, seed transmission and mechanical spread by insects.

At the present time, no effective chemicals will control virus diseases. Therefore, sanitation and use of resistant varieties of plants has been the most effective means of controlling plant viruses.

In some instances, when the spread of the virus is slow, loss from disease can be reduced by removing diseased plants and replacing them with healthy replants. This method has been used to reduce losses from peach mosaic. Reducing the population of insect vectors by insecticides or by other means, such as elimination of host plants for the insects, has given at least partial control of some virus diseases.

WEED KILLER INJURY

Weed killers or herbicides are chemicals designed to kill woody and/or herbaceous plants. Weed killers can be classified as preemergence, postemergence, contact and soil sterilants. The three most common injury symptoms are: (1) hormone effect, when foliage take on a grotesque or gnarled, twisted appearance. (2) root inhibitor, where severe root pruning results in a dieback of top growth, and (3) chlorophyll inhibition which causes foliage to turn white to pinkish white. Most herbicide injury can be prevented merely by following label directions. Mixtures of fertilizers and herbicides should be used with extreme caution around the home landscape. If problems are found and herbicide injury suspected, specimens and/or inquiries should be sent to the weed control specialists with the Texas Agricultural Extension Service.

WILT DISEASES

Wilt symptoms are caused in a large number of broadleaf plants by several species of Fusarium and Verticillium fungi. The fungi differ one from another but the symptoms which they cause are very similar. The only reliable method for separating these diseases is laboratory culture and identification of the fungus isolated from diseased plants.

Plants first show a wilted appearance. Individual branches or even single leaves may be affected at first. Leaves develop a yellow color, often in V-shaped sectors between the major veins. Leaves eventually die and fall.

Discoloration or brown streaking is often found in vascular tissues. The fungus can be readily isolated from the diseased stems. Diseased plants may die soon after first symptoms or they may sprout at the base after the top dies.

The wilt fungi have different general characteristics which will aid in identification and control. These are:

1. Verticillium thrives in alkaline soil whereas Fusarium grows best in acid soils.
2. Fusarium is more prevalent in sandy soil; Verticillium in heavy soils.
3. Fusarium causes more injury when root-knot, reniform or string nematodes injure the roots; Verticillium does not require injury for infection.
4. Fusarium can be transmitted internally in seed while Verticillium is not.
5. Verticillium prefers cooler soil than Fusarium.

The two diseases have some characteristics in common. These are:

1. Both thrive with high nitrogen fertilizer, excessive soil moisture, thin stands, and deep cultivation during the growing season.
2. Both fungi survive long periods in soil in the absence of a cultivated host.

Control of wilt diseases is difficult. Carefully follow suggested cultural practices. Rotation with tolerant plants and clean tillage to destroy infected tissue will help.

Plant breeders have selected many sources of genetic resistance to each wilt disease. Acceptable tolerant varieties have been developed in tomato, cotton, watermelons, and other crops. Growers should plant these improved varieties when they are equal to the susceptible varieties in yield, adaptation, and other cultural characteristics. Seed catalogs and other descriptive literature will give specific information on the tolerance of varieties to wilt diseases. Since new races of the fungi may develop that attack resistant varieties, it is necessary that growers keep up with the latest information on resistant varieties and control measures.

WINTER INJURY

Freeze. Winter injury to landscape plants often happens when sudden, unseasonably cold weather occurs in the fall. Many plants are still growing in the fall and have not hardened off for the coming winter. The hardening process takes place naturally as gradually colder weather invades during the fall. Succulence, maintained by late-season fertilizer applications and high soil moisture, predisposes shrubs and trees to cold injury. The primary factor for winter damage is cold that is severe, sudden, and possibly of longer than normal duration.

Winter damage is often not noticed until the following spring or summer. The affects may also be seen 2 or 3 years later. Affected plants may bloom and leaf out but when the hot summer days arrive, they quickly wilt and die. This is usually due to damage in the cambium layer on major limbs or the trunk. The healthy portion of the plant is able to translocate enough water and nutrients in the spring when requirements are light but when the demand for water increases, it fails to keep up. Peaches, apricots, apples, plums and other fruit trees respond in this manner.

In diagnosing trees that die suddenly in late spring and early summer, cut the bark at the crown line to see if the root system is still alive. If the root system is still living or shows greener wood than the above ground portion, then winter damage should be suspected. Freeze damage results in a darkening of the wood just under the bark of the trunk and main branches. By carving on the tree and locating these dark areas, one can often find differences in color from one side of the trunk or branch to the other. The darkest wood is often found on the south exposure. With some woody ornamentals, the bark cracks or splits. Azaleas commonly show this type symptom.

Water Stress. Evergreens, such as Arizona cypress, cedar, juniper, ligustrum, may suffer winter injury when inadequate moisture is available or when soil temperatures are considerable below air temperatures. Although these plants do not transpire as much water in the winter as they do in the summer, they still remain active and thus may need additional water in the winter months. When soils are cold and warm dry winds blow, roots cannot take up enough water to balance the loss through the leaves. Yellowing and browning of the foliage and even death may occur. These conditions are most likely to exist in late winter or early spring. Evergreens suffer less damage if protected by wind breaks.

Some plant species have a lower tolerance to cold temperature than others. Before purchasing landscape plants, obtain information regarding winter hardiness. In many areas of the state, azalea, boxwood, ligustrum, oleander, pyracantha, pittosporum, fig, crapemyrtle and hibiscus may be damaged during cold winters. Injury may consist of only a few tips or branches dying back. When this is the case, judicious pruning will improve the looks and balance the top growth but it should be done after the exact dead areas are determined. Lawn grasses may also suffer winter injury. As with other plants, healthy turf will be damaged less than turf stressed or weakened by insects, diseases, drought stress or lack of fertilizer.

Winter injury can be lessened or entirely prevented. The following measures should be considered and practiced when applicable: (1) Select winter hardy plants. (2) Assist the hardening process by withholding fertilizer and water in the late summer and fall. (3) In dry areas, supply adequate water after plants go dormant. (4) Avoid poorly drained soils. (5) Pick planting sites that protect susceptible plants from high winds. (6) Keep evergreens watered. (7) Keep plants healthy with proper watering, fertilizing and pruning.

WITHERING AND SCORCHING OF FOLIAGE
- POSSIBLE CAUSES -

Leaves first show a burning or scorching around margins, usually with older leaves being affected first. The marginal scorch progresses inward until the entire leaf withers and drops. The extent and rapidity of leaf drop is dependent on the type of plant and cause of damage.

Many types of plants show symptoms of withering and scorching when unfavorable conditions exist. These conditions can be grouped into the following categories:

1. Root Failure - One of the most common causes of withering and scorching. Roots may be damaged by such things as diseases, insects or factors that exclude oxygen from the soil. Certain insects, diseases or nematodes may devitalize enough of the root system to seriously hamper its function. When this occurs the leaves are not furnished with enough water and nutrients to supply to top. Such is the case with plants infested with root knot nematodes. Knots or galls form on roots and the entire system is devitalized to the point that the plant may be clorotic and stunted along with scored leaves.

   Root failure often results when oxygen is not available to roots. Such is the case with overwatering, fill soil, soil compaction or natural gas leaks. Roots are killed when oxygen is excluded, carbon dioxide accumulates and the pH of the soil is reduced. Gases and toxic compounds may also be produced by anaerobic bacteria under these conditions and some can survive much better than others. Post oak trees are more sensitive than live oak, for example.

   Many things can damage roots and careful observation is necessary to properly identify causes. Withering and scorching caused by root failure results from roots being unable to absorb and translocate enough water and nutrients to adequately furnish the plants.

2. Soil Deficiencies or Toxicities - Another common cause of withering and scorching is shortage of water and nutrients. If these are short enough in supply the entire leaf area cannot be furnished with water. When this condition exists, areas furthest from the source (leaf margins) will begin to scorch. As the problem becomes more acute, scorching will progress toward the center of the leaf. Watering according to need with good quality water and fertilizing according to soil test represent the best means of prevention.

   Toxicity can also result in withering and scorching of foliage. Toxic materials vary in the way they affect plants. Excessive use of fertilizer burns roots and causes root failure described earlier. Certain herbicides may kill roots directly while others translocate to foliage tissue, with these often accumulating on leaf margins and scorching occurs. Many substances are toxic to plants and their modes of action differ.

3. Atmospheric toxicity - Certain air pollutants may produce a scorching of the leaf surface. Several described pollutants are capable of causing damage and these are identified in the section on air

pollution. Sulfur dioxide causes a scorching around leaf edges initially. This could be confused with damage caused by root failure or toxic substances.

4. Vascular diseases - Plants or trees infected with vascular disease organisms such as Fusarium wilt, Verticillium wilt, or oak wilt may have scorched leaves. Water transporting vessels become plugged and prevent normal translocation.

CULTURAL PRACTICES FOR REDUCING CROP DISEASES

Certain cultural practices are invaluable in reducing plant disease losses. A control program is enhanced whenever one can utilize as many methods of control as possible. New strains of an organism may develop that will attack resistant varieties or become tolerant to certain pesticides when these practices are used alone. Combining practices reduces the risk of failure.

Rotation with unrelated crops is probably the most utilized cultural practice for disease control. This helps keep populations of pathogens from building up to damaging numbers. One should not expect rotation to eliminate disease development, but it certainly aids in reducing damage from most diseases.

Fertilizer usage may have some bearing on development of certain diseases. It differs with each crop and each disease but, in general, nitrogen out of balance with other nutrients enhances foliage disease development and predisposes some plants to other diseases. Potash, on the other hand, helps reduce disease development when it is in balance with other elements.

Deep burial of crop residue helps control certain diseases by placing the organism contained in the residue at a depth where there is an oxygen deficiency. This reduces the population of the disease-causing organism and permits the crop to escape much of the damage.

Planting on a raised bed is helpful in preventing certain diseases such as Southern blight and certain of the wilt diseases. This practice is advisable when growing leguminous crops such as peanuts, soybeans, and guar, and when growing vegetable crops in tight, poorly drained soils.

Burning of crop residue has been discouraged because of destruction of valuable organic matter and creation of an air pollution problem. The fact remains, however, that it is a highly effective means of eradicating some disease-causing organisms associated with crop residue. This practice has found some utility in controlling disease problems in permanent stands of coastal bermudagrass.

Time of seeding has an important bearing on disease prevention in many cases. Delayed planting of wheat will help escape the chances of wheat streak mosaic virus. Early spring planting of cotton may effectively help escape cotton root rot.

Removal of undesirable plants that might serve as a host reservoir for virus diseases that attack cultivated crops aid in preventing infection. Infected rhizomes of Johnsongrass are the primary overwintering host (for the maize dwarf mosaic virus that attacks grain sorghum, forage sorghum, and corn. Wild <u>Solanaceae</u> weeds, such as jimsonweed, horsenettel and silverleaf nightshade harbor viruses that attack potato and tomato.

Volunteer plants from a harvested crop are often means of carrying a disease organism from one crop season to the next. Rusts of cereal crops and spinach constitute an example of this type disease dissemination.

Roguing (removal) of diseased plants as they appear is often an effective method in helping reduce the spread of a destructive disease. Virus diseases of stone fruits and bacterial wilt of curcurbits are examples where roguing is worthy of consideration.

These cultural control practices have been found to be economically feasible in reducing disease losses. Growers should properly identify the diseases that limit production and then use a variety of controls in combination.

DIAGNOSIS OF PLANT DISEASE AND NEMATODE PROBLEMS

Correct diagnosis is the first step in controlling a condition caused by disease organisms or nematodes. Since fungi, bacteria, nematodes, mycoplasma and viruses are microscopic in size, it is necessary to follow certain procedures to insure proper identification. The following series of steps will aid in taking a more direct approach.

1. Carefully observe all symptoms associated with a condition. Formulate a description in your mind or on paper and check to see if the statement is true without exception.

2. Compare plants to see if they are similarly affected in all parts of the field or yard.

3. See if non-related plants are similarly affected. Most disease-causing organisms are host specific and do not affect a large number of plant types. If a similar leaf spot or burn is observed on different plant types, then one might expect a drift of toxic substances. On the other hand, certain diseases like cotton root rot might affect a number of plants, but you could rule out corn or other grasses, which are not susceptible.

4. Get as much information as possible to help diagnose the problem. County Extension agents have a number of publications that will be helpful.

5. If it is not possible to correctly identify the problem at this point, one should select a representative specimen for observation by the county Extension agent.

6. Microscopic examination may be required. If this is the case, a specimen can be mailed to the Texas Plant Disease Diagnostic Laboratory, Room 101, L. F. Peterson Building, Texas A&M University, College Station, Texas 77843. There is a $10.00 fee for each sample. Forms are available from your county Extension office explaining how to collect, package, and mail specimens.

7. Samples for nematode analysis should be sent to the Plant Nematode Detection Laboratory, Room 101, L. F. Peterson Building, Texas A&M University, College Station, Texas 77843. (Agents have printed suggestions for collection of samples.) A $10.00 fee for each sample will be charged.

EQUIPMENT (DUSTERS AND SPRAYERS)

Dusters: Dusting equipment is available in all practical sizes ranging from one-half to 25 pounds or more in dust capacity. Small piston or plunger-type dusters are convenient when only a few plants are involved, but for the most efficient application on a large area, continuous flow models of the bellows-operated or hand-cranked, rotary type are preferred. Regardless of type, extension tubes or dust-deflecting accessories are essential for coverage of hard to reach places and undersurfaces of low growing plants.

For best results and maximum personal safety, dust when air is calm and plant surfaces are damp, but not wet. Dusting wet surfaces causes unsightly deposits on leaves. After dusting, remove excess dust from the hopper to prevent caking in storage and possible corrosion of metal parts.

Hose-on Sprayers: Of the many different types of spray equipment on the market, the hose proportioner or hose-on sprayer probably is the most widely used around the home. Its popularity is due mostly to low costs, simplicity, and versatility in applying all kinds of spray materials. This sprayer attaches to the end of a garden hose and meters the pesticide out through a siphon to mix with water from the hose. The chief difference between models of hose-on sprayers is the metering system used to regulate dosage. The simplest models have a non-adjustable nozzle and siphon system calibrated so that a set volume of water is required to empty the pesticide container. These are available in sizes calibrated to deliver three to 15 gallons of spray for each jar of chemical used. Sprayers with the lower rates are best suited for spraying plant foliage; the 15 gallon size is best for lawns.

More versatile types of hose-on sprayers are equipped with an adjustable nozzle so that spray volume can be regulated. These work better with emulsifiable concentrates than with wettable powders. Dosage is regulated by a dial setting that meters out desired amounts of pesticide concentrate for each gallon of spray applied. Using the proper dial setting, the amount of concentrate placed in the pesticide jar does not affect dosage; therefore, do not dilute materials in the jar with water. Some disadvantages of hose-on sprayers are: (1) their use is limited to the area reached by hose, (2) difficulty in obtaining uniform spray coverage in large, dense shrubbery and on undersides of low-growing plants and (3) water pressure may not be sufficient to break the spray into the fine mist needed for good plant coverage.

Compressed Air Sprayers: These sprayers operate on air pressure (20 to 80 psi) developed by a hand-operated air pump. They will handle wettable powders as well as liquids, provided the spray tank is agitated frequently to keep material in suspension. Tank sizes range from two quarts to five gallons or more with the largest sizes normally mounted on wheels for handling ease. Quality features for this type of sprayer include a corrosion-resistant tank fitted with a large filler opening for cleaning ease, a pump equipped with replaceable parts and a reasonably long extension tube fitted with a rotating, adjustable nozzle.

Trombone Sprayers: These also are hand operated, but operating pressure is developed by the action of a sliding rod or piston to force liquid through the spray nozzle. Pressures up to 180 psi are possible, and liquids can be sprayed up to 30 feet depending on nozzle adjustment. This sprayer most commonly is fitted with a suction hose that can be dropped into any size container of spray mix. The larger models are the best choice of all hand-operated equipment for spraying large shrubs and fruit trees.

Powered Equipment: Large areas require equipment operated by an engine or tractor power takeoff. Boom-type or single nozzle tree sprayers used for application of fungicides should be equipped with piston-type pumps for handling wettable powder formulations with minimum wear and capable of developing spray pressures in excess of 100 pounds per square inch (psi). Pumps developing 300 psi or greater are needed for certain orchard spraying. Turbine or air-blast sprayers designed to deliver spray materials by wind rather than liquid pressure and gravity are versatile and provide excellent coverage of orchard trees up to 30 feet in height. Smaller editions of the air blast sprayer are the back pack type models commonly called mist blowers. These are useful for estate work, small orchards and commercial greenhouses. Airplane services are available in most localities and often are needed when crops cannot otherwise be sprayed conveniently. Effectiveness of air application depends in large part on environmental conditions. Fungicidal sprays should be applied by air under the combined conditions of low air humidity, temperatures below 85°F and winds not exceeding 15 miles per hour.

ESTIMATING PLANT DISEASE LOSSES

Loss estimates are necessary to properly evaluate damage caused by plant diseases. Development of this type of information is needed to determine what course of control action is needed and how much money can be spent on programs to reduce losses. Damage caused by disease organisms is often attributed to factors such as weather conditions instead of the disease itself. This natural tendency occurs because disease producing organisms are microscopic in size and not visible to the unaided eye.

It is rare indeed to be able to calculate the actual loss due to diseases and for this reason estimates are necessary. For example, a field of grain may be uniformly infected with an organism such as rust. This means that an unaffected area is not available for yield comparison. It is possible for one to use chemical control to protect an area but even then control may not be complete or the fungicides may alter plant growth.

Since we do rely on estimates, they shoud be considered as such and not referred to as fact. This does not brand estimates as inaccurate, but places them in proper perspective. Even factual evidence becomes an estimate when it is extended to refer to disease occurrence in another field or in another year. Carefully considered estimates are valuable and can be used to plan research, educational or control decision making activities.

After estimates are carefully established, errors in calculated losses are often made. This happens when an individual figures his estimated loss percentage against what was actually made when it should be considered against the potential yield without any disease. The following problem will depict the correct and incorrect method of figuring losses by using an estimated percentage.

PROBLEM: A farmer made 2,500 pounds of peanuts per acre. He did not control leaf spot and it is estimated that the disease produces a 15 percent loss. How many peanuts did he lose?

RIGHT

15% loss
85% = 2,500 lbs.

2941.00 = potential yield
.85/2500.00
170
800
765
350
340
100
85

2941 potential yield
-2500
441 pounds lost

WRONG

2500 lbs. yield
x15%
12,500
2,500
375.00 pounds lost

Several steps can be taken to improve the accuracy of estimates. Using the most effective chemical control possible permits one to determine how much loss can be recovered. Replicated treated and untreated plots improve accuracy. Even though this type of control is not usually 100 percent, one gets information that has a high level of reliability.

Using disease resistant varieties in comparison with susceptible ones is often beset with inaccuracy because of differences in yield potential. Observations may be helpful, but one should resist the temptation of over-extending confidence when other varieties are involved.

There is no substitute for careful field observation. Mathematical computations may enhance the presentation of findings, but it still is no more accurate than the initial input. Carefully made estimates are valuable and necessary for decision making.

FUNGICIDE ADDITIVES

It is sometimes desirable to add certain materials to fungicides to improve final results. Additives or adjuvants can be placed in one of the following categories:

1. Diluents - any liquid or solid material used to dilute active ingredient and make it less concentrated.

2. Surfactants - materials added to a fungicide formulation to ensure that powders are easily wettable and well dispersed in the spray tank.

3. Spreader-stickers - materials used to increase the spreading of spray droplets on plant surfaces and render the residue more tenacious.

4. Modifers - compounds added to pesticide formulations to enhance biological activity or reduce plant damage.

Fungicide additives when needed are usually added to the product during formulation. This ensures product stability and performance. In some cases manufacturers will suggest that certain products be added at the time of use. If a label does not specify the use of an additive, one should realize that he assumes the risk of undesirable results if any should occur. Certain fungicides become toxic to plants when oils or spreader-stickers are added. The safest approach is to abstain from the use of additives unless the label so specifies.

INSPECTION AND CERTIFICATION

Inspection of propagative plant material followed by certification that it is free of disease is an effective means of preventing movement of disease organisms from one area to another. Inspection of plant material is carried out by federal and state agencies. The federal government has the responsibility of preventing diseased plant material from entering the United States. This is accomplished by preventing agricultural commodities from crossing the border. The Texas Department of Agriculture is responsible for certification of seed, vegetatively propagated material and nursery stock. A copy of the Texas Seed Certification Standards (which includes vegetatively propagated material) is available from the Texas Department of Agriculture, P.O. Box 12847, Austin, Texas 78711.

SEED TREATMENT (INCLUDING TUBERS, CORMS AND OTHER PROPAGATIVE PLANT PARTS)

Controlling a disease may often be achieved by a single procedure such as chemical treatment. Numerous plant disease organisms live over from year to year because spores of the pathogen are carried on or in the seed. When such contaminated seed is planted, the seed-borne microorganisms revive, start to grow and become active parasites, destroying the seed or attacking the seedling as it grows. One purpose of seed treatments by the use of chemical protectants is to destroy seed-borne microorganisms that cause seedling blights and seed decay. Many microscopic molds and bacteria live in the soil and many of these are pathogenic. Chemical seed treatment is used to provide a protective zone around the seed which soil-borne microorganisms cannot penetrate, thus protecting the developing tender seedling against attack until it is well established and has acquired the capability of outgrowing attacks from soil-borne pathogens.

Some plant disease-inciting fungi are carried within the seed. As the seed sprouts, the fungus grows inside the developing seedling, resulting in disease symptoms in the mature plant. Loose smut of wheat and barley is caused by a fungus of this type. Systemic seed treatment fungicides are necessary to control this type of fungus.

There is no one seed treatment method or material that may be recommended as a universal preventative for all of the pathogens that attack seed and seedlings. Certain liquid treatment materials recommended for small grains would be ineffective when used on seed such as beans and peas. Some of the seed treatment chemicals are poisonous to animals and humans and great care must be exercised when handling these products. Even though some seed treatment chemicals may not actually be poisonous, most of them like house dust, can be irritating to the eyes and nose. Chemically treated seed should never be used for livestock feed or human consumption.

Seed treatment is a useful and indispensable tool in our defense against plant disease. Various methods and compounds for seed treatment are discussed in this publication.

NON-CHEMICAL CONTROL OF PLANT DISEASES IN THE HOME GARDEN

Plants are considered diseased when they do not grow and develop normally. The cause of such a condition may result from infection by disease-causing organisms or from environmental factors. Organisms known to cause disease are bacteria, fungi, nematodes, viruses, mycoplasmas and parasitic seed plants. Examples of environmental disorders are air pollution, poor soil, excessive heat, low or excessive nutrition, and drought.

When organisms cause disease, it is usually due to a parasitic relationship with a host plant. The parasite, or causal organism, is called a pathogen. The interaction between host and pathogen results in disease. This discussion is limited to diseases where a pathogen is involved. Most plant problems arising from environmental conditions are covered under such topics as fertilization, water management and other cultural procedures.

Prevention is the best approach to plant disease control when using either chemical or non-chemical (organic) methods. Prevention may involve suppressing the disease agent or avoiding the disease. Utilizing as many disease-preventative practices as possible will ensure the best possible control. Many of the following practices aid in controlling many different disease problems that arise. Examples regarding ways they have been used are given where clarification is needed. "Root Knot Nematode Control" is covered in a separate section. Also, refer to sections on "Cultural Practices for Disease Control", and discussions on disease for specific plants.

SUPPRESSING THE DISEASE AGENT

1. Rotation. Vegetables in the same family group are more likely to be susceptible to the same soil-borne diseases. Cantaloupes and watermelons, for example, have common diseases. If they follow each other in a rotation, a disease organism may be limited on the first crop but sustain enough carry-over in the soil to cause severe loss on the following crop. Vegetables from different family groups should be rotated because they are usually not susceptible to the same disease organisms. The groups listed below should be rotated so a selection from one group is not planted in the same location more than once every 2 to 3 years. Limited garden space may prevent an ideal rotation system.

Table 1. Crop grouping for rotation to control soil-borne diseases

GROUP A	GROUP B	GROUP C	GROUP D	GROUP E	GROUP F
Cantaloupe	Brussels Sprout	Eggplant	Beet	Sweet Corn	Bean
Cucumber	Cabbage	Irish Potato	Carrot		Cowpea
Honeydew Melon	Cauliflower	Okra	Garlic		Pea
Pumpkin	Collards	Pepper	Onion		
Squash	Lettuce	Tomato	Shallot		
Watermelon	Mustard		Sweet Potato		
	Radish				
	Rutabaga				
	Spinach				
	Swiss Chard				
	Turnip				

2. Organic Matter. Organic matter increases the number and kind of microorganisms in the soil. Many of these microorganisms compete with disease agents for nourishment. In most cases, the best organic matter is obtained by turning under a green cover crop, such as a small grain (wheat, oats, barley, cereal rye) or a legume.

3. Resistant Varieties. Agricultural scientists have made great strides in developing disease-resistant varieties. Resistance, however, is a relative term and does not indicate immunity. For example, a tomato plant resistant to Fusarium wilt may develop wilt if stressed but not become diseased to the degree that a susceptible variety might. Resistance could be expressed as slower disease development which allows resistant plants to produce an acceptable yield before or without losing vigor to disease attack.

4. Sanitation. Any crop residue destruction practice that reduces the disease agent's ability to reproduce or overseason could be included under sanitation. Examples are raking and burning diseased leaves and disposing of infected fruit. Root knot nematode-infested plants should be dug and as much of the root system as possible removed from the garden site. Root knot nematodes are harder to kill when protected by root tissue. Diseased leaves, fruits, and other plant parts should not be piled near the garden. Fungi, for instance, often

produce thousands of spores in the reproductive process, and these spores can be wind-blown great distances. Diseased plant tissue should be buried, burned, or disposed of in some other way that prevents the dispersal of the disease agent. In most cases, it is best not to put diseased plant parts in a compost pile. This is especially true for nematode-infected plants. Although many disease organisms are destroyed by heat during composting, 100 percent kill is not normally obtained. Contaminated compost will only serve to spread disease organisms as the compost is being used. Compost for the garden could be made with grass clippings or shrubs and tree leaves, as the disease organisms on grass and leaves are not likely to affect garden plants.

5. Heat Treatment. Heating small amounts of soil is practical for potted plants and for growing seedling transplants. The soil should be moist but not saturated. Heat the soil at 180°F for approximately 3 hours in a standard oven. An average-sized Irish potato placed in the middle of the soil can act as an indicator. When it is cooked, the soil should be sterile. Microwave ovens have also been used for sterilizing small quantities. Using high power, heat the soil for 3 minutes. Do not overheat using either system. Excessive heating will release certain elements in the soil to toxic levels. A new heating approach that has not been fully tested is called solar pasteurization or solarization. Developed in Israel, it simply consists of covering well tilled, moist soil with clear plastic, sealing the edges, and leaving it for several weeks. Black plastic should not be used because soil heating will not be as great as heating under clear plastic. The best results reported thus far have been with control of fungi, principally those causing root rots. Certain weeds and nematodes have also been controlled but not on a consistent basis. Solar pasteurization will work best on land not cropped for one month and during the hottest months. August should be ideal for home garden sites. This technique looks promising but needs more testing under Texas conditions to determine its specific role in disease control.

6. Fallowing. Leaving land idle and clean through the growing season will reduce disease agents in the soil. Fallowing is especially helpful if done in the summer months when soil temperatures are high. Frequent plowing will keep the soil dry and free of plant growth and expose soil-borne disease organisms, such as nematodes, to killing heat and excessive drying. Other benefits of fallowing are weed and insect control. This practice is most efficient if rainfall is low and temperatures are high.

7. Weed Control. Weeds harbor insects and serve as hosts for many virus diseases. For most viruses to survive they must remain in a living organism whether it be a host plant or insect. Destroying weeds in and around the garden may eliminate potential overwintering host plants.

AVOIDING DISEASE

1. Change Planting Date. Some disease can be controlled by changing the planting date. Spring-planted squash usually escapes mosaic virus, whereas fall-planted squash does not. Warm-season vegetables, like peas and okra, should be planted after soils warm sufficiently to avoid seedling disease.

2. Obtain Disease-Free Planting Stock. It is advisable to check transplants such as cabbage, tomatoes, peppers, and others for root knot nematode galls. Certified Irish seed potatoes are less likely to harbor a disease such as black leg. Some disease agents are seed transmitted; thus, only the best seed should be planted.

3. Cultural practices

   a. Select the best site. Choose a site with deep, well drained soil.

   b. Plant on raised beds. Raised beds improve drainage. They also warm up faster than level soil which aids in faster emergence. Slow emergence increases chances of seedling disease.

   c. Use proper plant spacing. Crowded plants reduce air circulation which enhances leaf spot diseases. Septoria leaf spot on tomato is an example. However, in Far West Texas, with low humidity and few leaf spot diseases, crowding tomato plants may reduce losses to curly top virus by shading the plants and making them less attractive to the insect vector.

   d. Overplant. Overplanting where possible will ensure enough production if some plants or fruit are lost to disease.

   e. Proper fertilization. Plants receiving all needed nutrients may resist some of the less vigorous disease-causing organisms.

   f. Do not overwater. Excessively wet conditions increase soil-borne fungal diseases like root rots and wilts.

   g. Avoid overhead irrigation. Leaf spot diseases develop rapidly when leaves are moist.

   h. Do not prune roots. Roots cut while cultivating reduce plant vigor and leave openings for root rot and wilt fungi to enter.

ROOT KNOT NEMATODE CONTROL

No doubt many gardens have become infested by planting contaminated transplants or by bringing in topsoil harboring root knot nematodes. Taking steps to prevent this problem is just as important as implementing the steps to control this once it has become a problem. Where soils are already infested and a garden is first put into production, nematode levels are generally low. After several years of gardening and growing susceptible plants, the nematode population increases to the point that damage becomes unacceptable. Control practices that can be used are summer fallowing, rotation, adding organic matter, planting trap crops, removing diseased plants, and using resistant varieties. All these control measures are designed to reduce the nematode population in the soil.

The benefits of summer fallowing have already been discussed. Removing all potential hosts and keeping the soil dry will reduce the nematode population, as the nematode requires a moist environment for survival. Additional years of fallowing will further reduce the nematode population.

Rotation with non-hosts or poor hosts of the root knot nematode is also another means of reducing the population. Sweet corn is a poor host and is good to use in a rotation, especially in an area where root knot has done severe damage. Onions, garlic, asparagus, and shallots are also poor hosts. Cool-season crops such as cabbage, Irish potatoes, greens (turnips), radishes, and broccoli are less likely to suffer yield loss from root knot nematodes. Even though these are susceptible plants, they grow best in the cooler time of the year which is not favorable for root knot nematode development.

High soil organic matter alone will not ensure root knot nematode control. The higher the organic matter, however, the better the chance that antagonistic organisms will develop. There are soil fungi that trap nematodes and utilize them as a food source. Some organic matter tends to work better than others. Turning under a green manure crop such as small grains or legumes several weeks before planting has shown to be the best. Additional nitrogen may be necessary for adequate crop production because decay organisms in the soil will utilize available nitrogen as they break down the green manure crop.

Sometimes people resort to using home remedies to control nematodes such as planting marigolds or mixing sugar or lye into the soil. Of these three, only French marigolds are effective in controlling nematode populations, and their effectiveness has limitations and is often questionable.

Some people think that marigolds secrete a toxic substance into the soil that kills nematodes and that planting a few marigolds around annual plants in infested soil will prevent infection. This is not true. Marigolds merely act as a trap crop. Nematodes are able to enter their roots but are unable to complete their life cycle. The trapped nematodes die without reproducing.

The type of marigold is also important. French marigolds, *Tagetes patula*, are more effective in controlling root knot nematodes than the African marigold *Tagetes erecta*, which is also referred to as the American, Big, or Aztec marigold. To be effective, marigolds must be planted as a solid crop and grown for 90 to 120 days to effectively reduce the nematode population sufficiently to grow annual plants without treatment. Marigolds should be planted in rows no further than seven inches between each plant, so that the roots penetrate the entire soil mass to trap as many nematodes as possible. If marigolds are planted close together, they form a dense canopy which helps retard the development of weeds and grasses. Many weeds and grasses serve as hosts for root knot nematodes. If the weeds are not controlled, the marigolds may be unable to suppress the nematode population.

Using marigolds in a manner other than that recommended can invite disaster. For example, planting a few marigolds here and there among tomatoes will encourage spider mites. The spider mite is one of the most difficult garden pests to control and can become nearly as serious a problem as the nematodes.

All nematode-infected plants should be removed from the garden as soon after production ceases as possible. Removing the root systems will eliminate many of the nematodes. To ensure that as much of the root system as possible is removed, use a shovel rather than just pulling the plant up by the stem.

Root knot resistant vegetable varieties are not plentiful. Fortunately, progress has been made in the development of root knot resistant tomatoes. The best resistance is found in the hybrid varieties that have been developed in recent years. Root knot resistant varieties are noted in seed catalogs by "N" following the variety name. Preceding the "N" are often "V" and "F". "VFN" stands for verticillium wilt resistance, fusarium wilt resistance, and nematode resistance. Hybrid tomato seed is more expensive than open-pollinated seed, but the benefits in disease resistance alone are enough to make it worth buying.

Diseases caused by root knot nematodes and other organisms can be prevented with non-chemical methods that either avoid the disease or suppress the disease agent. However, maximum control can only be assured by utilizing as many of these disease preventive practices as possible.

[Blank Page in Original Bulletin]

For Sale - $15

Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Zerle L. Carpenter, Director, Texas Agricultural Extension Service, The Texas A&M University System.
2M—4-88, Revision PP